New Zealand's Compliance with the Standards and Recommended Practices of Annex 10 to the Convention on International Civil Aviation - Aeronautical Telecommunications, Volume I (Radio Navigation Aids) including all amendments up to and including Amendment 81 applicable 23 November 2006

CHAPTER 1. DEFINITIONS

When the following terms are used in this volume, they have the following meanings:

Altitude. The vertical distance of a level, a point or an object considered as a point, measured from mean sea level (MSL).

Effective acceptance bandwidth. The range of frequencies with respect to the assigned frequency for which reception is assured when all receiver tolerances have been taken into account.

Effective adjacent channel rejection. The rejection that is obtained at the appropriate adjacent channel frequency when all relevant receiver tolerances have been taken into account.

Elevation. The vertical distance of a point or a level, on or affixed to the surface of the earth, measured from mean sea level.

Fan marker beacon. A type of radio beacon, the emissions of which radiate in a vertical fan-shaped pattern.

Height. The vertical distance of a level, a point or an object considered as a point, measured from a specified datum.

Human Factors principles. Principles which apply to design, certification, training, operations and maintenance and which seek safe interface between the human and other system components by proper consideration to human performance.

Mean power (of a radio transmitter). The average power supplied to the antenna transmission line by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions.

Pressure-altitude. An atmospheric pressure expressed in terms of altitude which corresponds to that pressure in the Standard Atmosphere.

Protected service volume. A part of the facility coverage where the facility provides a particular service in accordance with relevant SARPs and within which the facility is afforded frequency protection.

Touchdown. The point where the nominal glide path intercepts the runway.

Z marker beacon. A type of radio beacon, the emissions of which radiate in a vertical cone-shaped pattern.

CHAPTER 2. GENERAL PROVISIONS FOR RADIO NAVIGATION AIDS

The following types of radio aids to navigation operate within the New Zealand FIR and Auckland Oceanic FIR:

(a) MF Non-Directional Beacons (NDB)

(b) Marine Radio Beacons

(c) VHF Direction-Finding Stations (VDF)

(d) VHF Omni-Directional Radio Range (VOR)

(e) Distance Measuring Equipment (DME)

(f) Instrument Landing System (ILS)

(g) Tactical Air Navigation Aid (TACAN)

(h) VOR and TACAN combination (VORTAC)

Also operating within the New Zealand FIR are:

(a) Primary Surveillance Radar (PSR)

(b) Secondary Surveillance Radar (SSR)

2.1 Aids to approach, landing and departure

2.1.1

The standard non-visual aids to precision approach and landing shall be:

a) the instrument landing system (ILS) conforming to the Standards contained in Chapter 3, 3.1;

b) the microwave landing system (MLS) conforming to the Standards contained in Chapter 3, 3.11; and

c) the global navigation satellite system (GNSS) conforming to the Standards contained in Chapter 3, 3.7.

Compliance Statement

Note: New Zealand has not deployed MLS.

2.1.1.1

It shall be permissible to replace a non-visual aid with an alternative non-visual aid on the basis of regional air navigation agreement.

Compliance Statement

Regional agreement.

2.1.1.2*

The agreements indicated in 2.1.1.1 should provide at least a five-year notice.

Compliance Statement

Regional agreement.

2.1.1.3

When a non-visual aid is to be provided, its performance shall correspond at least to the category of precision approach runway to be served.

Compliance Statement

Ref.: Annex 10 Compliance Statement.

2.1.2

Differences in non-visual aids in any respect from the Standards of Chapter 3 shall be published in an Aeronautical Information Publication (AIP).

Compliance Statement

AIP New Zealand GEN 3.7 RADIO COMMUNICATION AND NAVIGATION FACILITIES

2.1.2.1

Non-visual aids that do not conform:

a) to the Standards in Chapter 3, 3.1.2.1, 3.1.2.2 and 3.1.7.1 a) shall not be described by the term ILS;

b) to the Standards in Chapter 3, 3.11.3 shall not be described by the term MLS.

Compliance Statement

Ref.: Annex 10 Compliance Statement.

2.1.3

Wherever there is installed a non-visual aid that is neither an ILS nor an MLS, but which may be used in whole or in part with aircraft equipment designed for use with the ILS or MLS, full details of parts that may be so used shall be published in an Aeronautical Information Publication (AIP).

Compliance Statement

Not applicable.

2.1.4*

A precision approach radar (PAR) system conforming to the Standards contained in Chapter 3, 3.2 and equipment for two-way communication with aircraft, together with facilities for the efficient co-ordination of these elements with air traffic control, should be installed and operated as a supplement to a non-visual aid wherever:

a) air traffic control will be materially assisted by such installation in the landing of aircraft intending to use a non-visual aid; and

b) the accuracy or expedition of final approaches or the facilitation of approaches by aircraft not equipped to use a non-visual aid will be materially aided by such installation.

Compliance Statement

New Zealand does not utilise the precision approach radar system as defined (PAR + SRE); New Zealand has no PAR.

2.1.4.1*

Only the precision approach radar (PAR) element of the precision approach radar system conforming to the Standards contained in Chapter 3, 3.2.3, together with the equipment and facilities prescribed in 2.1.4 should be installed when it is determined that the surveillance radar element (SRE), associated with the precision approach radar system, is not necessary to meet the requirements of air traffic control for the handling of aircraft intending to use a non-visual aid.

Compliance Statement

Not applicable.

2.1.4.2*

Although SRE is not considered a satisfactory alternative to the precision approach radar system, an SRE conforming to the Standards contained in Chapter 3, 3.2.4 and equipment for two-way communication with aircraft should be installed and operated for:

a) the assistance of air traffic control in handling aircraft intending to use a non-visual aid;

b) surveillance radar approaches and departures.

Compliance Statement

PSRs, with a maximum range of up to 80NM, are installed and operated at the following locations for the assistance of air traffic control in handling aircraft intending to use a non-visual aid:

(a) Auckland Airport;

(b) Christchurch Airport; and

(c) Hawkins Hill (3.5NM west of Wellington Airport).

These PSR operate at 12 rpm (5 sec/rev) and therefore are not fully compliance with Standard 3.2.4.4. which requires that the equipment shall be capable of completely renewing the information concerning the distance and azimuth of any aircraft within the coverage of the equipment at least once every 4 seconds.

2.1.5*

A non-visual aid should be supplemented, as necessary, by a source or sources of guidance information which, when used in conjunction with appropriate procedures, will provide effective guidance to, and efficient coupling (manual or automatic) with, the desired reference path.

Compliance Statement

New Zealand uses NDB (locators), VOR/DME and VORTAC.

Reference instrument approach procedures

2.1.6 Required navigation performance (RNP) for approach, landing and departure operations

2.1.6.1

Where used, RNP for approach, landing and departure operations shall be prescribed by States.

Compliance Statement

RNP approach and departure procedures at Queenstown.

2.1.6.2

Where RNP is prescribed for precision approach and landing operations, the RNP shall only be supported by a standard non-visual aid in accordance with 2.1.1. (ILS/MLS/GNSS)

Compliance Statement

RNP approaches are based on GNSS (Queenstown)

2.2 Short-distance aids

2.2.1

In localities and along routes where conditions of traffic density and low visibility necessitate a ground based short-distance radio aid to navigation for the efficient exercise of air traffic control, or where such short-distance aid is required for the safe and efficient conduct of aircraft operations, the standard aid shall be the

VHF omnidirectional radio range (VOR) of the continuous wave phase comparison type conforming to the Standards contained in Chapter 3, 3.3.

Compliance Statement

New Zealand primary enroute and terminal aid is the VOR/DME.

2.2.1.1*

Means should be provided for the pre-flight checking of VOR airborne equipment at aerodromes regularly used by international air traffic.

Compliance Statement

VOR/INS checkpoints – reference AIP New Zealand AD2.

Advisory Circular AC 139-6A provides the specification for VOR check-point signs.

2.2.2

At localities 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, distance measuring equipment (DME) (conforming to the Standards in Chapter 3, 3.5) shall be installed and maintained in operation as a complement to VOR.

Compliance Statement

New Zealand primary enroute and terminal aid is the VOR/DME.

2.2.2.1

DME/N equipment first installed after 1 January 1989 shall also conform to the Standards in Chapter 3, 3.5 denoted by ‡.

Compliance Statement

Ref.: Annex 10 Compliance Statement.

2.3 Radio beacons

2.3.1 Non-directional radio beacons (NDB)

2.3.1.1

An NDB conforming to the Standards in Chapter 3, 3.4 shall be installed and maintained in operation at a locality where an NDB, in conjunction with direction-finding equipment in the aircraft, fulfils the operational requirement for a radio aid to navigation.

Compliance Statement

Reference AIP New Zealand.

2.3.2 En-route VHF marker beacons (75 MHz)

2.3.2.1*

Where a VHF marker beacon is required to mark a position on any air route, a fan marker beacon conforming to the Standard contained in Chapter 3, 3.6 should be installed and maintained in operation.

2.3.2.2*

Where a VHF marker beacon is required to mark the position of a radio navigation aid giving directional or track guidance, a Z marker conforming to the Standard in Chapter 3, 3.6 should be installed and maintained in operation.

Compliance Statement

Not applicable.

2.4 Global navigation satellite system (GNSS)

Civil Aviation Rules Part 19 Subpart D (IFR Operations: GNSS) prescribes the conditions and requirements for the use of GNSS equipment under IFR.

2.4.1

A standard aid to navigation shall be the global navigation satellite system (GNSS) conforming to the Standards contained in Chapter 3, 3.7.

Compliance Statement

Ref.: Annex 10 Compliance Statement.

2.4.2

It shall be permissible to terminate a GNSS satellite service provided by one of its elements (Chapter 3, 3.7.2) on the basis of at least a six-year advance notice by a service provider.

Compliance Statement

Not applicable.

2.4.3 Recording and retention of GNSS data

2.4.3.1 *

A State that approves GNSS-based operations should ensure that GNSS data relevant to those operations are recorded.

Compliance Statement

In accordance with Civil Aviation Rule 19.207 (Primary means GPS operations) each person operating an aircraft under IFR using GPS equipment as a primary means navigation system shall, amongst other things, if intending to use a GPS based instrument approach procedure, obtain a RAIM prediction prior to departure for the expected time of arrival at the destination—

(i) using the onboard GPS receiver; or

(ii) from the holder of an air traffic service organisation certificate issued under Part 172; and

And ensure that en-route and terminal navigation is conducted—

(i) using a GPS database containing data that is current with respect to the current en-route and area charts applicable to the route being flown; and

(ii) by cross checking each GPS database selected track and distance between reporting points, for accuracy and reasonableness by reference to current en-route and area charts.

And ensure all GPS instrument approaches are accomplished in accordance with approved instrument approach procedures using a GPS database containing data that is current with respect to the current published Instrument Approach Chart for the approach procedure being flown.

GNSS data is recorded by Airways Corporation of New Zealand (Airways) (Australian RAIM Prediction Service) and Land Information New Zealand (LINZ).

Australian RAIM Prediction Service

Aeronautical Information Circular (AIC) H20/98, dated 16 July 1998, provides details of the Australian GPS Receiver Autonomous Integrity Monitoring (RAIM) Prediction Service. This service is an enhancement to the pre-flight briefing services provided for those aerodromes with a GPS non-precision approach. New Zealand, Tonga, Canada and East Timor now also use the Australian RAIM Prediction Service.

2.4.3.2 *

Recordings should be retained for a period of at least fourteen days. When the recordings are pertinent to accident and incident investigations, they should be retained for longer periods until it is evident that they will no longer be required.

Compliance Statement

Obtainable from the Australian RAIM Prediction Service or LINZ.

2.5 Reserved

2.6 Distance measuring aids

2.6.1*

If a distance measuring facility is installed and maintained in operation for any radio navigational purpose additional to that specified in 2.2.2 it should conform to the specification in Chapter 3, 3.5.

Compliance Statement

Ref.: Annex 10 Compliance Statement.

2.7 Ground and flight testing

2.7.1

Radio navigation aids of the types covered by the specifications in Chapter 3 and available for use by aircraft engaged in international air navigation shall be the subject of periodic ground and flight tests.

Compliance Statement

Difference:- Some NDB and locator beacons are not the subject of periodic flight tests. Stand alone NDB are only flight tested as required for special or post accident/incident inspection.

2.8 Provision of information on the operational status of radio navigation aids

2.8.1

Aerodrome control towers and units providing approach control service shall be provided without delay with information on the operational status of radio navigation aids essential for approach, landing and take-off at the aerodrome(s) with which they are concerned.

Compliance Statement

Ref.: Annex 10 Compliance Statement.

2.9 Secondary power supply for radio navigation aids and communication systems

2.9.1

Radio navigation aids and ground elements of communication systems of the types specified in Annex 10 shall be provided with suitable power supplies and means to ensure continuity of service appropriate to the needs of the service provided.

Compliance Statement

Ref.: Annex 10 Compliance Statement.

2.10 Human Factors considerations

2.10.1*

Human Factors principles should be observed in the design and certification of radio navigation aids.

Compliance Statement

Ref.: Annex 10 Compliance Statement.

CHAPTER 3. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

Compliance Statement

Ref.: Annex 10 Compliance Statement.

Note: Differences have been notified with regard to paragraphs:-

3.1.3.3

3.1.4

3.1.5.3

3.1.7.6.2.1*

3.1.7.6.3.1*

3.3.8

3.4.8.2*

3.4.8.4*

3.5.3.6.3 (a)

3.5.4.7.2.1 (a)

3.5.4.7.2.3*

3.1 Specification for ILS

3.1.1 Definitions

Angular displacement sensitivity. The ratio of measured DDM to the corresponding angular displacement from the appropriate reference line.

Back course sector. The course sector which is situated on the opposite side of the localizer from the runway.

Course line. The locus of points nearest to the runway centre line in any horizontal plane at which the DDM is zero.

Course sector. A sector in a horizontal plane containing the course line and limited by the loci of points nearest to the course line at which the DDM is 0.155.

Displacement sensitivity (localizer). The ratio of measured DDM to the corresponding lateral displacement from the appropriate reference line.

DDM - Difference in depth of modulation. The percentage modulation depth of the larger signal minus the percentage modulation depth of the smaller signal, divided by 100.

Facility Performance Category I - ILS. An ILS which provides guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the ILS glide path at a height of 60 m (200 ft) or less above the horizontal plane containing the threshold.

Facility Performance Category II - ILS. An ILS which provides guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the ILS glide path at a height of 15 m (50 ft) or less above the horizontal plane containing the threshold.

Facility Performance Category III - ILS. An ILS which, with the aid of ancillary equipment where necessary, provides guidance information from the coverage limit of the facility to, and along, the surface of the runway.

Front course sector. The course sector which is situated on the same side of the localizer as the runway.

Half course sector. The sector, in a horizontal plane containing the course line and limited by the loci of points nearest to the course line at which the DDM is 0.0775.

Half ILS glide path sector. The sector in the vertical plane containing the ILS glide path and limited by the loci of points nearest to the glide path at which the DDM is 0.0875.

ILS continuity of service. That quality which relates to the rarity of radiated signal interruptions. The level of continuity of service of the localizer or the glide path is expressed in terms of the probability of not losing the radiated guidance signals.

ILS glide path. That locus of points in the vertical plane containing the runway centre line at which the DDM is zero, which, of all such loci, is the closest to the horizontal plane.

ILS glide path angle. The angle between a straight line which represents the mean of the ILS glide path and the horizontal.

ILS glide path sector. The sector in the vertical plane containing the ILS glide path and limited by the loci of points nearest to the glide path at which the DDM is 0.175.

ILS integrity. That quality which relates to the trust which can be placed in the correctness of the information supplied by the facility. The level of integrity of the localizer or the glide path is expressed in terms of the probability of not radiating false guidance signals.

ILS Point "A". A point on the ILS glide path measured along the extended runway centre line in the approach direction a distance of 7.5 km (4 NM) from the threshold.

ILS Point "B". A point on the ILS glide path measured along the extended runway centre line in the approach direction a distance of 1 050 m (3 500 ft) from the threshold.

ILS Point "C". A point through which the downward extended straight portion of the nominal ILS glide path passes at a height of 30 m (100 ft) above the horizontal plane containing the threshold.

ILS Point "D". A point 4 m (12 ft) above the runway centre line and 900 m (3 000 ft) from the threshold in the direction of the localizer.

ILS Point "E". A point 4 m (12 ft) above the runway centre line and 600 m (2 000 ft) from the stop end of the runway in the direction of the threshold.

ILS reference datum (Point "T"). A point at a specified height located above the intersection of the runway centre line and the threshold and through which the downward extended straight portion of the ILS glide path passes.

Two-frequency glide path system. An ILS glide path in which coverage is achieved by the use of two independent radiation field patterns spaced on separate carrier frequencies within the particular glide path channel.

Two-frequency localizer system. A localizer system in which coverage is achieved by the use of two independent radiation field patterns spaced on separate carrier frequencies within the particular localizer VHF channel.

3.1.2 Basic requirements

3.1.2.1

The ILS shall comprise the following basic components:

a) VHF localizer equipment, associated monitor system, remote control and indicator equipment;

b) UHF glide path equipment, associated monitor system, remote control and indicator equipment;

c) VHF marker beacons, or distance measuring equipment (DME) in accordance with section 3.5, together with associated monitor systems and remote control and indicator equipment.

3.1.2.1.1

Facility Performance Categories I, II and III - ILS shall provide indications at designated remote control points of the operational status of all ILS ground system components.

3.1.2.2

The ILS shall be constructed and adjusted so that, at a specified distance from the threshold, similar instrumental indications in the aircraft represent similar displacements from the course line or ILS glide path as appropriate, irrespective of the particular ground installation in use.

3.1.2.3

The localizer and glide path components specified in 3.1.2.1 a) and b) above which form part of a Facility Performance Category I - ILS shall comply at least with the Standards in 3.1.3 and 3.1.5 below respectively, excepting those in which application to Facility Performance Category II - ILS is prescribed.

3.1.2.4

The localizer and glide path components specified in 3.1.2.1 a) and b) above which form part of a Facility Performance Category II - ILS shall comply with the Standards applicable to these components in a Facility Performance Category I - ILS, as supplemented or amended by the Standards in 3.1.3 and 3.1.5 below in which application to Facility Performance Category II - ILS is prescribed.

3.1.2.5

The localizer and glide path components and other ancillary equipment specified in 3.1.2.1.1 above, which form part of a Facility Performance Category III - ILS, shall otherwise comply with the Standards applicable to these components in Facility Performance Categories I and II - ILS, except as supplemented by the Standards in 3.1.3 and 3.1.5 below in which application to Facility Performance Category III - ILS is prescribed.

3.1.2.6

To ensure an adequate level of safety, the ILS shall be so designed and maintained that the probability of operation within the performance requirements specified is of a high value, consistent with the category of operational performance concerned.

3.1.2.7

At those locations where two separate ILS facilities serve opposite ends of a single runway, an interlock shall ensure that only the localizer serving the approach direction in use shall radiate, except where the localizer in operational use is Facility Performance Category I - ILS and no operationally harmful interference results.

3.1.2.7.1*

At those locations where two separate ILS facilities serve opposite ends of a single runway and where a Facility Performance Category I - ILS is to be used for auto-coupled approaches and landings in visual conditions an interlock should ensure that only the localizer serving the approach direction in use radiates, providing the other localizer is not required for simultaneous operational use.

3.1.2.7.2

At locations where ILS facilities serving opposite ends of the same runway or different runways at the same airport use the same paired frequencies, an interlock shall ensure that only one facility shall radiate at a time. When switching from one ILS facility to another, radiation from both shall be suppressed for not less than 20 seconds.

3.1.3 VHF localizer and associated monitor

Introduction

The specifications of this 3.1.3 cover ILS localizers providing either positive guidance information over 360 degrees of azimuth, or providing such guidance only within a specified portion of the front coverage (see 3.1.3.7.4 below). Where ILS localizers providing positive guidance information in a limited sector are installed, information from some suitably located navigation aid, together with appropriate procedures, will generally be required to ensure that any misleading guidance information outside the sector is not operationally significant.

3.1.3.1 General

3.1.3.1.1

The radiation from the localizer antenna system shall produce a composite field pattern which is amplitude modulated by a 90 Hz and a 150 Hz tone. The radiation field pattern shall produce a course sector with one tone predominating on one side of the course and with the other tone predominating on the opposite side.

3.1.3.1.2

When an observer faces the localizer from the approach end of a runway, the depth of modulation of the radio frequency carrier due to the 150 Hz tone shall predominate on his right hand and that due to the 90 Hz tone shall predominate on his left hand.

3.1.3.1.3

All horizontal angles employed in specifying the localizer field patterns shall originate from the centre of the localizer antenna system which provides the signals used in the front course sector.

3.1.3.2 Radio frequency

3.1.3.2.1

The localizer shall operate in the band 108 MHz to 111.975 MHz. Where a single radio frequency carrier is used, the frequency tolerance shall not exceed plus or minus 0.005 per cent. Where two radio frequency carriers are used, the frequency tolerance shall not exceed 0.002 per cent and the nominal band occupied by the carriers shall be symmetrical about the assigned frequency. With all tolerances applied, the frequency separation between the carriers shall not be less than 5 kHz nor more than 14 kHz.

3.1.3.2.2

The emission from the localizer shall be horizontally polarized. The vertically polarized component of the radiation on the course line shall not exceed that which corresponds to a DDM error of 0.016 when an aircraft is positioned on the course line and is in a roll attitude of 20 degrees from the horizontal.

3.1.3.2.2.1

For Facility Performance Category II localizers, the vertically polarized component of the radiation on the course line shall not exceed that which corresponds to a DDM error of 0.008 when an aircraft is positioned on the course line and is in a roll attitude of 20 degrees from the horizontal.

3.1.3.2.2.2

For Facility Performance Category III localizers, the vertically polarized component of the radiation within a sector bounded by 0.02 DDM either side of the course line shall not exceed that which corresponds to a DDM error of 0.005 when an aircraft is in a roll attitude of 20 degrees from the horizontal.

3.1.3.2.3

For Facility Performance Category III localizers, signals emanating from the transmitter shall contain no components which result in an apparent course line fluctuation of more than 0.005 DDM peak to peak in the frequency band 0.01 Hz to 10 Hz.

3.1.3.3 Coverage

Difference:- Because of siting problems and terrain limitations some localizers do not meet Category I facility performance criteria for off course clearance.

3.1.3.3.1

The localizer shall provide signals sufficient to allow satisfactory operation of a typical aircraft installation within the localizer and glide path coverage sectors. The localizer coverage sector shall extend from the centre of the localizer antenna system to distances of:

46.3 km (25 NM) within plus or minus 10 degrees from the front course line;

31.5 km (17 NM) between 10 degrees and 35 degrees from the front course line;

18.5 km (10 NM) outside of plus or minus 35 degrees if coverage is provided;

except that, where topographical features dictate or operational requirements permit, the limits may be reduced to 33.3 km (18 NM) within the plus or minus 10-degree sector and 18.5 km (10 NM) within the remainder of the coverage when alternative navigational facilities provide satisfactory coverage within the intermediate approach area. The localizer signals shall be receivable at the distances specified at and above a height of 600 m (2 000 ft) above the elevation of the threshold, or 300 m (1 000 ft) above the elevation of the highest point within the intermediate and final approach areas, whichever is the higher. Such signals shall be receivable, to the distances specified, up to a surface extending outward from the localizer antenna and inclined at 7 degrees above the horizontal.

3.1.3.3.2

In all parts of the coverage volume specified in 3.1.3.3.1 above, other than as specified in 3.1.3.3.2.1, 3.1.3.3.2.2 and 3.1.3.3.2.3 below, the field strength shall be not less than 40 microvolts per metre (minus 114 dBW/m2).

3.1.3.3.2.1

For Facility Performance Category I localizers, the minimum field strength on the ILS gate path and within the localizer course sector from a distance of 18.5 km (10 NM) to a height of 60 m (200 ft) above the horizontal plane containing the threshold shall be not less than 90 microvolts per metre (minus 107 dBW/m2).

3.1.3.3.2.2

For Facility Performance Category II localizers, the minimum field strength on the ILS glide path and within the localizer course sector shall be not less than 100 microvolts per metre (minus 106 dBW/m2) at a distance of 18.5 km (10 NM) increasing to not less than 200 microvolts per metre (minus 100dBW/m2) at a height of 15 m (50 ft) above the horizontal plane containing the threshold.

3.1.3.3.2.3

For Facility Performance Category III localizers, the minimum field strength on the ILS glide path and within the localizer course sector shall be not less than 100 microvolts per metre (minus 106 dBW/m2) at a distance of 18.5 km (10 NM), increasing to not less than 200 microvolts per metre (minus 100 dBW/m2) at 6 m (20 ft) above the horizontal plane containing the threshold. From this point to a further point 4 m (12 ft) above the runway centre line, and 300 m (1 000 ft) from the threshold in the direction of the localizer, and thereafter at a height of 4 m (12 ft) along the length of the runway in the direction of the localizer, the field strength shall be not less than 100 microvolts per metre (minus 106 dBW/m2).

3.1.3.3.3*

Above 7 degrees, the signals should be reduced to as low a value as practicable.

3.1.3.3.4

When coverage is achieved by a localizer using two radio frequency carriers, one carrier providing a radiation field pattern in the front course sector and the other providing a radiation field pattern outside that sector, the ratio of the two carrier signal strengths in space within the front course sector to the coverage limits specified at 3.1.3.3.1 above shall not be less than 10 dB.

3.1.3.3.5*

For Facility Performance Category III localizers, the ratio of the two carrier signal strengths in space within the front course sector should not be less than 16 dB.

3.1.3.4 Course structure

3.1.3.4.1 For Facility Performance Category I localizers, bends in the course line shall not have amplitudes which exceed the following:

(See Annex for data)

3.1.3.4.2

For Facility Performance Categories II and III localizers, bends in the course line shall not have amplitudes which exceed the following:

(See Annex for data)

3.1.3.5 Carrier modulation

3.1.3.5.1

The nominal depth of modulation of the radio frequency carrier due to each of the 90 Hz and 150 Hz tones shall be 20 per cent along the course line.

3.1.3.5.2

The depth of modulation of the radio frequency carrier due to each of the 90 Hz and 150 Hz tones shall be within the limits of 18 and 22 per cent.

3.1.3.5.3

The following tolerances shall be applied to the frequencies of the modulating tones:

a) the modulating tones shall be 90 Hz and 150 Hz within plus or minus 2.5 per cent;

b) the modulating tones shall be 90 Hz and 150 Hz within plus or minus 1.5 per cent for Facility Performance Category II installations;

c) the modulating tones shall be 90 Hz and 150 Hz within plus or minus 1 per cent for Facility Performance Category III installations;

d) the total harmonic content of the 90 Hz tone shall not exceed 10 per cent; additionally, for Facility Performance Category III localizers, the second harmonic of the 90 Hz tone shall not exceed 5 per cent;

e) the total harmonic content of the 150 Hz tone shall not exceed 10 per cent.

3.1.3.5.3.1*

For Facility Performance Category I - ILS, the modulating tones should be 90 Hz and 150 Hz within plus or minus 1.5 per cent where practicable.

3.1.3.5.3.2

For Facility Performance Category III localizers, the depth of amplitude modulation of the radio frequency carrier at the power supply frequency or its harmonics, or by other unwanted components, shall not exceed 0.5 per cent. Harmonics of the supply, or other unwanted noise components that may intermodulate with the 90 Hz and 150Hz navigational tones or their harmonics to produce fluctuations in the course line, shall not exceed 0.05 per cent modulation depth of the radio frequency carrier.

3.1.3.5.3.3

The modulation tones shall be phase-locked so that within the half course sector, the demodulated 90 Hz and 150 Hz wave forms pass through zero in the same direction within:

a) for Facility Performance Categories I and II localizers: 20 degrees; and

b) for Facility Performance Category III localizers: 10 degrees,

of phase relative to the 150 Hz component, every half cycle of the combined 90 Hz and 150 Hz wave form.

3.1.3.5.3.4

With two-frequency localizer systems, 3.1.3.5.3.3 above shall apply to each carrier. In addition, the 90 Hz modulating tone of one carrier shall be phase-locked to the 90 Hz modulating tone of the other carrier so that the demodulated wave forms pass through zero in the same direction within:

a) for Categories I and II localizers: 20 degrees; and

b) for Category III localizers: 10 degrees,

of phase relative to 90 Hz. Similarly, the 150 Hz tones of the two carriers shall be phase-locked so that the demodulated wave forms pass through zero in the same direction within:

1) for Categories I and II localizers: 20 degrees; and

2) for Category III localizers: 10 degrees,

of phase relative to 150 Hz.

3.1.3.5.3.5

Alternative two-frequency localizer systems that employ audio phasing different from the normal inphase conditions described in 3.1.3.5.3.4 above shall be permitted. In this alternative system, the 90 Hz to 90 Hz phasing and the 150 Hz to 150 Hz phasing shall be adjusted to their nominal values to within limits equivalent to those stated in 3.1.3.5.3.4 above.

3.1.3.5.3.6*

The sum of the modulation depths of the radio frequency carrier due to the 90 Hz and 150 Hz tones should not exceed 60 per cent or be less than 30 per cent within the required coverage.

3.1.3.5.3.6.1

For equipment first installed after 1 January 2000, the sum of the modulation depths of the radio frequency carrier due to the 90 Hz and 150 Hz tones shall not exceed 60 per cent or be less than 30 per cent within the required coverage.

3.1.3.5.3.7

When utilizing a localizer for radiotelephone communications, the sum of the modulation depths of the radio frequency carrier due to the 90 Hz and 150 Hz tones shall not exceed 65 per cent within 10 degrees of the course line and shall not exceed 78 per cent at any other point around the localizer.

3.1.3.5.4

Undesired frequency and phase modulation on ILS localizer radio frequency carriers that can affect the displayed DDM values in localizer receivers should be minimized to the extent practical.

3.1.3.6 Course alignment accuracy

3.1.3.6.1

The mean course line shall be adjusted and maintained within limits equivalent to the following displacements from the runway centre line at the ILS reference datum:

a) for Facility Performance Category I localizers: plus or minus 10.5 m (35 ft), or the linear equivalent of 0.015 DDM, whichever is less;

b) for Facility Performance Category II localizers: plus or minus 7.5 m (25 ft);

c) for Facility Performance Category III localizers: plus or minus 3 m (10 ft).

3.1.3.6.2

For Facility Performance Category II localizers, the mean course line should be adjusted and maintained within limits equivalent to plus or minus 4.5 m (15 ft) displacement from runway centre line at the ILS reference datum.

3.1.3.7 Displacement sensitivity

3.1.3.7.1

The nominal displacement sensitivity within the half course sector at the ILS reference datum shall be 0.00145 DDM/m (0.00044 DDM/ft) except that for Category I localizers, where the specified nominal displacement sensitivity cannot be met, the displacement sensitivity shall be adjusted as near as possible to that value. For Facility Performance Category I localizers on runway codes 1 and 2, the nominal displacement sensitivity shall be achieved at the ILS Point “B”. The maximum course sector angle shall not exceed 6 degrees.

3.1.3.7.2

The lateral displacement sensitivity shall be adjusted and maintained within the limits of plus or minus:

a) 17 per cent of the nominal value for Facility Performance Categories I and II;

b) 10 per cent of the nominal value for Facility Performance Category III.

3.1.3.7.3

For Facility Performance Category II - ILS, displacement sensitivity should be adjusted and maintained within the limits of plus or minus 10 per cent where practicable.

3.1.3.7.4

The increase of DDM shall be substantially linear with respect to angular displacement from the front course line (where DDM is zero) up to an angle on either side of the front course line where the DDM is 0.180. From that angle to plus or minus 10 degrees, the DDM shall not be less than 0.180. From plus or minus 10 degrees to plus or minus 35 degrees, the DDM shall not be less than 0.155. Where coverage is required outside of the plus or minus 35 degrees sector, the DDM in the area of the coverage, except in the back course sector, shall not be less than 0.155.

3.1.3.8 Voice

3.1.3.8.1

Facility Performance Categories I and II localizers may provide a ground-to-air radiotelephone communication channel to be operated simultaneously with the navigation and identification signals, provided that such operation shall not interfere in any way with the basic localizer function.

3.1.3.8.2

Category III localizers shall not provide such a channel, except where extreme care has been taken in the design and operation of the facility to ensure that there is no possibility of interference with the navigational guidance.

3.1.3.8.3

If the channel is provided, it shall conform with the following Standards:

3.1.3.8.3.1

The channel shall be on the same radio frequency carrier or carriers as used for the localizer function, and the radiation shall be horizontally polarized. Where two carriers are modulated with speech, the relative phases of the modulations on the two carriers shall be such as to avoid the occurrence of nulls within the coverage of the localizer.

3.1.3.8.3.2

The peak modulation depth of the carrier or carriers due to the radiotelephone communications shall not exceed 50 per cent but shall be adjusted so that:

a) the ratio of peak modulation depth due to the radio-telephone communications to that due to the identification signal is approximately 9:1;

b) the sum of modulation components due to use of the radiotelephone channel, navigational signals and identification signals shall not exceed 95 per cent.

3.1.3.8.3.3

The audio frequency characteristics of the radiotelephone channel shall be flat to within 3 dB relative to the level at 1 000 Hz over the range 300 Hz to 3 000 Hz.

3.1.3.9 Identification

3.1.3.9.1

The localizer shall provide for the simultaneous transmission of an identification signal, specific to the runway and approach direction, on the same radio frequency carrier or carriers as used for the localizer function. The transmission of the identification signal shall not interfere in any way with the basic localizer function.

3.1.3.9.2

The identification signal shall be produced by Class A2A modulation of the radio frequency carrier or carriers using a modulation tone of 1 020 Hz within plus or minus 50 Hz. The depth of modulation shall be between the limits of 5 and 15 per cent except that, where a radiotelephone communication channel is provided, the depth of modulation shall be adjusted so that the ratio of peak modulation depth due to radiotelephone communications to that due to the identification signal modulation is approximately 9:1 (see 3.1.3.8.3.2 above). The emissions carrying the identification signal shall be horizontally polarized. Where two carriers are modulated with identification signals, the relative phase of the modulations shall be such as to avoid the occurrence of nulls within the coverage of the localizer.

3.1.3.9.3

The identification signal shall employ the International Morse Code and consist of two or three letters. It may be preceded by the International Morse Code signal of the letter “I”, followed by a short pause where it is necessary to distinguish the ILS facility from other navigational facilities in the immediate area.

3.1.3.9.4

The identification signal shall be transmitted by dots and dashes at a speed corresponding to approximately seven words per minute, and shall be repeated at approximately equal intervals, not less than six times per minute, at all times during which the localizer is available for operational use. When the transmissions of the localizer are not available for operational use, as, for example, after removal of navigational components, or during maintenance or test transmissions, the identification signal shall be suppressed. The dots shall have a duration of 0.1 second to 0.160 second. The dash duration shall be typically three times the duration of a dot. The interval between dots and/or dashes shall be equal to that of one dot plus or minus 10 per cent. The interval between letters shall not be less than the duration of three dots.

3.1.3.10 Siting

3.1.3.10.1 The localizer antenna system shall be located on the extension of the centre line of the runway at the stop end, and the equipment shall be adjusted so that the course lines will be in a vertical plane containing the centre line of the runway served. The antenna system shall have the minimum height necessary to satisfy the coverage requirements laid down in 3.1.3.3 above, and the distance from the stop end of the runway shall be consistent with safe obstruction clearance practices.

3.1.3.11.Monitoring

3.1.3.11.1 The automatic monitor system shall provide a warning to the designated control points and cause one of the following to occur, within the period specified in 3.1.3.11.3.1 below, if any of the conditions stated in 3.1.3.11.2 below persists:

a) radiation to cease;

b) removal of the navigation and identification components from the carrier;

c) reversion to a lower category in the case of Facility Performance Categories II and III localizers where the reversion requirement exists.

3.1.3.11.2

The conditions requiring initiation of monitor action shall be the following:

a) for Facility Performance Category I localizers, a shift of the mean course line from the runway centre line equivalent to more than 10.5 m (35 ft), or the linear equivalent to 0.015 DDM, whichever is less, at the ILS reference datum;

b) for Facility Performance Category II localizers, a shift of the mean course line from the runway centre line equivalent to more than 7.5 m (25 ft) at the ILS reference datum;

c) for Facility Performance Category III localizers, a shift of the mean course line from the runway centre line equivalent to more than 6 m (20 ft) at the ILS reference datum;

d) in the case of localizers in which the basic functions are provided by the use of a single-frequency system, a reduction of power output to less than 50 per cent of normal, provided the localizer continues to meet the requirements of 3.1.3.3, 3.1.3.4 and 3.1.3.5 above;

e) in the case of localizers in which the basic functions are provided by the use of a two-frequency system, a reduction of power output for either carrier to less than 80 per cent of normal, except that a greater reduction to between 80 per cent and 50 per cent of normal may be permitted, provided the localizer continues to meet the requirements of 3.1.3.3, 3.1.3.4 and 3.1.3.5 above;

f) change of displacement sensitivity to a value differing by more than 17 per cent from the nominal value for the localizer facility.

3.1.3.11.2.1

In the case of localizers in which the basic functions are provided by the use of a two-frequency system, the conditions requiring initiation of monitor action should include the case when the DDM in the required coverage beyond plus or minus 10 degrees from the front course line, except in the back course sector, decreases below 0.155.

3.1.3.11.3

The total period of radiation, including period(s) of zero radiation, outside the performance limits specified in a), b), c), d), e) and f) of 3.1.3.11.2 above shall be as short as practicable, consistent with the need for avoiding interruptions of the navigation service provided by the localizer.

3.1.3.11.3.1

The total period referred to under 3.1.3.11.3 shall not exceed under any circumstances:

10 seconds for Category I localizers;

5 seconds for Category II localizers;

2 seconds for Category III localizers.

3.1.3.11.3.2

Where practicable, the total period under 3.1.3.11.3.1 should be reduced so as not to exceed two seconds for Category II localizers and one second for Category III localizers.

3.1.3.11.4

Design and operation of the monitor system shall be consistent with the requirement that navigation guidance and identification will be removed and a warning provided at the designated remote control points in the event of failure of the monitor system itself.

3.1.3.11.5

Any erroneous navigation signals on the carrier occurring during removal of navigation and identification components in accordance with 3.1.3.11.1 b) shall be suppressed within the total periods allowed in 3.1.3.11.3.1.

3.1.3.12. Integrity and continuity of service requirements

3.1.3.12.1

The probability of not radiating false guidance signals shall not be less than 1 - 0.5 × 10-9 in any one landing for Facility Performance Categories II and III localizers.

3.1.3.12.2

The probability of not radiating false guidance signals should not be less than 1 - 1.0 × 10 -7 in any one landing for Facility Performance Category I localizers.

3.1.3.12.3

The probability of not losing the radiated guidance signal shall be greater than:

a) 1 - 2 × 10-6 in any period of 15 seconds for Facility Performance Category II localizers or localizers intended to be used for Category III A operations (equivalent to 2 000 hours mean time between outages); and

b) 1 - 2 × 10-6 in any period of 30 seconds for Facility Performance Category III localizers intended to be used for the full range of Category III operations (equivalent to 4 000 hours mean time between outages).

3.1.3.12.4

The probability of not losing the radiated guidance signal should exceed 1 - 4 × 10-6 in any period of 15 seconds for Facility Performance Category I localizers (equivalent to 1 000 hours mean time between outages).

3.1.4 Interference immunity performance for ILS localizer receiving systems

Difference:- Not a mandatory requirement for ILS localizer receiving systems fitted to New Zealand registered aircraft.

3.1.4.1

After 1 January 1998, the ILS localizer receiving system shall provide adequate immunity to interference from two-signal, third-order intermodulation products caused by VHF FM broadcast signals having levels in accordance with the following:

(See Annex for formula)

for VHF FM sound broadcasting signals in the range 107.7 - 108.0 MHz

and

(See Annex for formula)

for VHF FM sound broadcasting signals below 107.7 MHz, where the frequencies of the two VHF FM sound broadcasting signals produce, within the receiver, a two-signal, third-order intermodulation product on the desired ILS localizer frequency.

N1 and N2 are the levels (dBm) of the two VHF FM sound broadcasting signals at the ILS localizer receiver input. Neither level shall exceed the desensitization criteria set forth in 3.1.4.2.

f = 108.1 - f1, where f1 is the frequency of N1, the VHF FM sound broadcasting signal closer to 108.1 MHz.

3.1.4.2

After 1 January 1998, the ILS localizer receiving system shall not be desensitized in the presence of VHF FM broadcast signals having levels in accordance with the following table:

(See Annex for data)

3.1.4.3

After 1 January 1995, all new installations of airborne ILS localizer receiving systems shall meet the provisions of 3.1.4.1 and 3.1.4.2 above.

3.1.4.4

Airborne ILS localizer receiving systems meeting the immunity performance standards of 3.1.4.1 and 3.1.4.2 above should be placed into operation at the earliest possible date.

3.1.5 UHF glide path equipment and associated monitor

3.1.5.1 General

3.1.5.1.1

The radiation from the UHF glide path antenna system shall produce a composite field pattern which is amplitude modulated by a 90 Hz and a 150 Hz tone. The pattern shall be arranged to provide a straight line descent path in the vertical plane containing the centre line of the runway, with the 150 Hz tone predominating below the path and the 90 Hz tone predominating above the path to at least an angle equal to 1.75 .

3.1.5.1.2

The UHF glide path equipment should be capable of adjustment to produce a radiated glide path from 2 to 4 degrees with respect to the horizontal.

3.1.5.1.2.1

The ILS glide path angle should be 3 degrees. ILS glide path angles in excess of 3 degrees should not be used except where alternative means of satisfying obstruction clearance requirements are impracticable.

3.1.5.1.2.2

The glide path angle shall be adjusted and maintained within:

a) 0.075 from for Facility Performance Categories I and II - ILS glide paths;

b) 0.04 from for Facility Performance Category III - ILS glide paths.

3.1.5.1.3

The downward extended straight portion of the ILS glide path shall pass through the ILS reference datum at a height ensuring safe guidance over obstructions and also safe and efficient use of the runway served.

3.1.5.1.4

The height of the ILS reference datum for Facility Performance Categories II and III - ILS shall be 15 m (50 ft). A tolerance of plus 3 m (10 ft) is permitted.

3.1.5.1.5

The height of the ILS reference datum for Facility Performance Category I - ILS should be 15 m (50 ft). A tolerance of plus 3 m (10 ft) is permitted.

3.1.5.1.6

The height of the ILS reference datum for Facility Performance Category I - ILS used on short precision approach runway codes 1 and 2 should be 12 m (40 ft). A tolerance of plus 6 m (20 ft) is permitted.

3.1.5.2 Radio frequency

3.1.5.2.1 The glide path equipment shall operate in the band 328.6 MHz to 335.4 MHz. Where a single radio frequency carrier is used, the frequency tolerance shall not exceed 0.005 per cent. Where two carrier glide path systems are used, the frequency tolerance shall not exceed 0.002 per cent and the nominal band occupied by the carriers shall be symmetrical about the assigned frequency. With all tolerances applied, the frequency separation between the carriers shall not be less than 4 kHz nor more than 32 kHz.

3.1.5.2.2

The emission from the glide path equipment shall be horizontally polarized.

3.1.5.2.3

For Facility Performance Category III - ILS glide path equipment, signals emanating from the transmitter shall contain no components which result in apparent glide path fluctuations of more than 0.02 DDM peak to peak in the frequency band 0.01 Hz to 10 Hz.

3.1.5.3 Coverage

Difference:- Because of siting problems and terrain limitations some glide paths do not meet Category I facility performance criteria up to 8 degrees in azimuth on each side of the centre line.

3.1.5.3.1 The glide path equipment shall provide signals sufficient to allow satisfactory operation of a typical aircraft installation in sectors of 8 degrees in azimuth on each side of the centre line of the ILS glide path, to a distance of at least 18.5 km (10 NM) up to 1.75 and down to 0.45 above the horizontal or to such lower angle, down to 0.30 , as required to safeguard the promulgated glide path intercept procedure.

3.1.5.3.2

In order to provide the coverage for glide path performance specified in 3.1.5.3.1 above, the minimum field strength within this coverage sector shall be 400 microvolts per metre (minus 95 dBW/m2). For Facility Performance Category I glide paths, this field strength shall be provided down to a height of 30 m (100 ft) above the horizontal plane containing the threshold. For Facility Performance Categories II and III glide paths, this field strength shall be provided down to a height of 15 m (50 ft) above the horizontal plane containing the threshold.

3.1.5.4 ILS glide path structure

3.1.5.4.1 For Facility Performance Category I - ILS glide paths, bends in the glide path shall not have amplitudes which exceed the following:

(See Annex for data)

3.1.5.4.2

For Facility Performance Categories II and III - ILS glide paths, bends in the glide path shall not have amplitudes which exceed the following:

(See Annex for data)

3.1.5.5 Carrier modulation

3.1.5.5.1 The nominal depth of modulation of the radio frequency carrier due to each of the 90 Hz and 150 Hz tones shall be 40 per cent along the ILS glide path. The depth of modulation shall not deviate outside the limits of 37.5 per cent to 42.5 per cent.

3.1.5.5.2

The following tolerances shall be applied to the frequencies of the modulating tones:

a) the modulating tones shall be 90 Hz and 150 Hz within 2.5 per cent for Facility Performance Category I - ILS;

b) the modulating tones shall be 90 Hz and 150 Hz within 1.5 per cent for Facility Performance Category II - ILS;

c) the modulating tones shall be 90 Hz and 150 Hz within 1 per cent for Facility Performance Category III - ILS;

d) the total harmonic content of the 90 Hz tone shall not exceed 10 per cent: additionally, for Facility Performance Category III equipment, the second harmonic of the 90 Hz tone shall not exceed 5 per cent;

e) the total harmonic content of the 150 Hz tone shall not exceed 10 per cent.

3.1.5.5.2.1

For Facility Performance Category I - ILS, the modulating tones should be 90 Hz and 150 Hz within plus or minus 1.5 per cent where practicable.

3.1.5.5.2.2

For Facility Performance Category III glide path equipment, the depth of amplitude modulation of the radio frequency carrier at the power supply frequency or harmonics, or at other noise frequencies, shall not exceed 1 per cent.

3.1.5.5.3

The modulation shall be phase-locked so that within the ILS half glide path sector, the demodulated 90 Hz and 150 Hz wave forms pass through zero in the same direction within:

a) for Facility Performance Categories I and II - ILS glide paths: 20 degrees;

b) for Facility Performance Category III - ILS glide paths: 10 degrees,

of phase relative to the 150 Hz component, every half cycle of the combined 90 Hz and 150 Hz wave form.

3.1.5.5.3.1

With two-frequency glide path systems, 3.1.5.5.3 above shall apply to each carrier. In addition, the 90 Hz modulating tone of one carrier shall be phase-locked to the 90 Hz modulating tone of the other carrier so that the demodulated wave forms pass through zero in the same direction within:

a) for Categories I and II - ILS glide paths: 20 degrees;

b) for Category III - ILS glide paths: 10 degrees,

of phase relative to 90 Hz. Similarly, the 150 Hz tones of the two carriers shall be phase-locked so that the demodulated wave forms pass through zero in the same direction, within:

1) for Categories I and II - ILS glide paths: 20 degrees;

2) for Category III - ILS glide paths: 10 degrees,

of phase relative to 150 Hz.

3.1.5.5.3.2

Alternative two-frequency glide path systems that employ audio phasing different from the normal inphase condition described in 3.1.5.5.3.1 above shall be permitted. In these alternative systems, the 90 Hz to 90 Hz phasing and the 150 Hz to 150 Hz phasing shall be adjusted to their nominal values to within limits equivalent to those stated in 3.1.5.5.3.1 above.

3.1.5.5.4

Undesired frequency and phase modulation on ILS glide path radio frequency carriers that can affect the displayed DDM values in glide path receivers should be minimized to the extent practical.

3.1.5.6 Displacement sensitivity

3.1.5.6.1 For Facility Performance Category I - ILS glide paths, the nominal angular displacement sensitivity shall correspond to a DDM of 0.0875 at angular displacements above and below the glide path between 0.07 and 0.14 .

3.1.5.6.2

For Facility Performance Category I - ILS glide paths, the nominal angular displacement sensitivity should correspond to a DDM of 0.0875 at an angular displacement below the glide path of 0.12 with a tolerance of plus or minus 0.02 . The upper and lower sectors should be as symmetrical as practicable within the limits specified in 3.1.5.6.1 above.

3.1.5.6.3

For Facility Performance Category II - ILS glide paths, the angular displacement sensitivity shall be as symmetrical as practicable. The nominal angular displacement sensitivity shall correspond to a DDM of 0.0875 at an angular displacement of:

a) 0.12 below path with a tolerance of plus or minus 0.02 ;

b) 0.12 above path with a tolerance of plus 0.02 and minus 0.05 .

3.1.5.6.4

For Facility Performance Category III - ILS glide paths, the nominal angular displacement sensitivity shall correspond to a DDM of 0.0875 at angular displacements above and below the glide path of 0.12 with a tolerance of plus or minus 0.02 .

3.1.5.6.5

The DDM below the ILS glide path shall increase smoothly for decreasing angle until a value of 0.22 DDM is reached. This value shall be achieved at an angle not less than 0.30 above the horizontal. However, if it is achieved at an angle above 0.45 , the DDM value shall not be less than 0.22 at least down to 0.45 or to such lower angle, down to 0.30 , as required to safeguard the promulgated glide path intercept procedure.

3.1.5.6.6

For Facility Performance Category I - ILS glide paths, the angular displacement sensitivity shall be adjusted and maintained within plus or minus 25 per cent of the nominal value selected.

3.1.5.6.7

For Facility Performance Category II - ILS glide paths, the angular displacement sensitivity shall be adjusted and maintained within plus or minus 20 per cent of the nominal value selected.

3.1.5.6.8

For Facility Performance Category III - ILS glide paths, the angular displacement sensitivity shall be adjusted and maintained within plus or minus 15 per cent of the nominal value selected.

3.1.5.7 Monitoring

3.1.5.7.1 The automatic monitor system shall provide a warning to the designated control points and cause radiation to cease within the periods specified in 3.1.5.7.3.1 if any of the following conditions persist:

a) shift of the mean ILS glide path angle equivalent to more than minus 0.075 to plus 0.10 from ;

b) in the case of ILS glide paths in which the basic functions are provided by the use of a single-frequency system, a reduction of power output to less than 50 per cent of normal, provided the glide path continues to meet the requirements of 3.1.5.3, 3.1.5.4 and 3.1.5.5;

c) in the case of ILS glide paths in which the basic functions are provided by the use of two-frequency systems, a reduction of power output for either carrier to less than 80 per cent of normal, except that a greater reduction to between 80 per cent and 50 per cent of normal may be permitted, provided the glide path continues to meet the requirements of 3.1.5.3, 3.1.5.4 and 3.1.5.5;

d) for Facility Performance Category I - ILS glide paths, a change of the angle between the glide path and the line below the glide path (150 Hz predominating) at which a DDM of 0.0875 is realized by more than plus or minus 0.0375 ;

e) for Facility Performance Categories II and III - ILS glide paths, a change of displacement sensitivity to a value differing by more than 25 per cent from the nominal value;

f) lowering of the line beneath the ILS glide path at which a DDM of 0.0875 is realized to less than 0.7475 from horizontal;

g) a reduction of DDM to less than 0.175 within the specified coverage below the glide path sector.

3.1.5.7.2

Monitoring of the ILS glide path characteristics to smaller tolerances should be arranged in those cases where operational penalties would otherwise exist.

3.1.5.7.3

The total period of radiation, including period(s) of zero radiation, outside the performance limits specified in 3.1.5.7.1 a), b), c), d), e) and f) shall be as short as practicable, consistent with the need for avoiding interruptions of the navigation service provided by the ILS glide path.

3.1.5.7.3.1

The total period referred to under 3.1.5.7.3 shall not exceed under any circumstances:

6 seconds for Category I - ILS glide paths;

2 seconds for Categories II and III - ILS glide paths.

3.1.5.7.3.2

Where practicable, the total period specified under 3.1.5.7.3.1 above for Categories II and III - ILS glide paths should not exceed 1 second.

3.1.5.7.4

Design and operation of the monitor system shall be consistent with the requirement that radiation shall cease and a warning shall be provided at the designated remote control points in the event of failure of the monitor system itself.

3.1.5.8 Integrity and continuity of service requirements

3.1.5.8.1 The probability of not radiating false guidance signals shall not be less than 1 - 0.5 × 10-9 in any one landing for Facility Performance Categories II and III glide paths.

3.1.5.8.2

The probability of not radiating false guidance signals should not be less than 1 - 1.0 × 10-7 in any one landing for Facility Performance Category I glide paths.

3.1.5.8.3

The probability of not losing the radiated guidance signal shall be greater than 1 - 2 × 10-6 in any period of 15 seconds for Facility Performance Categories II and III glide paths (equivalent to 2 000 hours mean time between outages).

3.1.5.8.4

The probability of not losing the radiated guidance signal should exceed 1 - 4 × 10-6 in any period of 15 seconds for Facility Performance Category I glide paths (equivalent to 1 000 hours mean time between outages).

3.1.6 Localizer and glide path frequency pairing

3.1.6.1

The pairing of the runway localizer and glide path transmitter frequencies of an instrument landing system shall be taken from the following list in accordance with the provisions of Volume V, Chapter 4, 4.2:

Localizer (MHz)	Glide path (MHz)
108.1	334.7
108.15	334.55
108.3	334.1
108.35	333.95
108.5	329.9
108.55	329.75
108.7	330.5
108.75	330.35
108.9	329.3
108.95	329.15
109.1	331.4
109.15	331.25
109.3	332.0
109.35	331.85
109.5	332.6
109.55	332.45
109.7	333.2
109.75	333.05

109.9	333.8
109.95	333.65
110.1	334.4
110.15	334.25
110.3	335.0
110.35	334.85
110.5	329.6
110.55	329.45
110.7	330.2
110.75	330.05
110.9	330.8
110.95	330.65
111.1	331.7
111.15	331.55
111.3	332.3
111.35	332.15
111.5	332.9
111.55	332.75
111.7	333.5
111.75	333.35
111.9	331.1
111.95	330.95

3.1.6.1.1

In those regions where the requirements for runway localizer and glide path transmitter frequencies of an instrument landing system do not justify more than 20 pairs, they shall be selected sequentially, as required, from the following list:

Sequence Number	Localizer (MHz)	Glide path (MHz)
1	110.3	335.0
2	109.9	333.8
3	109.5	332.6
4	110.1	334.4
5	109.7	333.2
6	109.3	332.0
7	109.1	331.4
8	110.9	330.8
9	110.7	330.2
10	110.5	329.6
11	108.1	334.7
12	108.3	334.1
13	108.5	329.9
14	108.7	330.5
15	108.9	329.3
16	111.1	331.7

17	111.3	332.3
18	111.5	332.9
19	111.7	333.5
20	111.9	331.1

3.1.6.2

Where existing ILS localizers meeting national requirements are operating on frequencies ending in even tenths of a megahertz, they shall be re-assigned frequencies, conforming with 3.1.6.1 or 3.1.6.1.1 as soon as practicable and may continue operating on their present assignments only until this re-assignment can be effected.

3.1.6.3

Existing ILS localizers in the international service operating on frequencies ending in odd tenths of a megahertz shall not be assigned new frequencies ending in odd tenths plus one twentieth of a megahertz except where, by regional agreement, general use may be made of any of the channels listed in 3.1.6.1 (see Volume V, Chapter 4, 4.2).

3.1.7 VHF marker beacons

3.1.7.1 General

a) There shall be two marker beacons in each installation except as provided in 3.1.7.6.6. A third marker beacon may be added whenever, in the opinion of the Competent Authority, an additional beacon is required because of operational procedures at a particular site.

b) The marker beacons shall conform to the requirements prescribed in 3.1.7. When the installation comprises only two marker beacons, the requirements applicable to the middle marker and to the outer marker shall be complied with.

c) The marker beacons shall produce radiation patterns to indicate predetermined distance from the threshold along the ILS glide path.

3.1.7.1.1

When a marker beacon is used in conjunction with the back course of a localizer, it shall conform with the marker beacon characteristics specified in 3.1.7.

3.1.7.1.2

Identification signals of marker beacons used in conjunction with the back course of a localizer shall be clearly distinguishable from the inner, middle and outer marker beacon identifications, as prescribed in 3.1.7.5.1.

3.1.7.2 Radio frequency

3.1.7.2.1

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

3.1.7.3 Coverage

3.1.7.3.1

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

a) inner marker (where installed): 150 m plus or minus 50 m (500 ft plus or minus 160 ft);

b) middle marker: 300 m plus or minus 100 m (1 000 ft plus or minus 325 ft);

c) outer marker: 600 m plus or minus 200 m (2 000 ft plus or minus 650 ft).

3.1.7.3.2

The field strength at the limits of coverage specified in 3.1.7.3.1 shall be 1.5 millivolts per metre (minus 82 dBW/m2). In addition, the field strength within the coverage area shall rise to at least 3.0 millivolts per metre (minus 76 dBW/m2).

3.1.7.4 Modulation

3.1.7.4.1

The modulation frequencies shall be as follows:

a) inner marker (when installed): 3 000 Hz;

b) middle marker: 1 300 Hz;

c) outer marker: 400 Hz.

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

3.1.7.4.2

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

3.1.7.5 Identification

3.1.7.5.1

The carrier energy shall not be interrupted. The audio frequency modulation shall be keyed as follows:

a) inner marker (when installed): 6 dots per second continuously;

b) 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;

c) outer marker: 2 dashes per second continuously.

These keying rates shall be maintained to within plus or minus 15 per cent.

3.1.7.6 Siting

3.1.7.6.1

The inner marker, when installed, shall be located so as to indicate in low visibility conditions the imminence of arrival at the runway threshold.

3.1.7.6.1.1

If the radiation pattern is vertical, the inner marker, when installed, should 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 centre line of the runway.

3.1.7.6.1.2

If the radiation pattern is other than vertical, the equipment should 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 and located as prescribed in 3.1.7.6.1.1.

3.1.7.6.2

The middle marker shall be located so as to indicate the imminence, in low visibility conditions, of visual approach guidance.

3.1.7.6.2.1*

If the radiation pattern is vertical, the middle marker should be located 1 050 m (3 500 ft) plus or minus 150 m (500 ft), from the landing threshold at the approach end of the runway and at not more than 75 m (250 ft) from the extended centre line of the runway.

Difference:- Due to topographical limitations middle markers are not always 1 050 plus or minus 150 metres from the landing threshold.

3.1.7.6.2.2

If the radiation pattern is other than vertical, the equipment should 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 and located as prescribed in 3.1.7.6.2.1.

3.1.7.6.3

The outer marker shall be located so as to provide height, distance and equipment functioning checks to aircraft on intermediate and final approach.

3.1.7.6.3.1*

The outer marker should be located 7.2 km (3.9 NM) from the threshold except that, where for topographical or operational reasons this distance is not practicable, the outer marker may be located between 6.5 and 11.1 km (3.5 and 6 NM) from the threshold.

Difference:- Due to topographical limitations outer markers are not always located between 6.5 and 11.1 km from the landing threshold.

3.1.7.6.4

If the radiation pattern is vertical, the outer marker should be not more than 75 m (250 ft) from the extended centre line of the runway. If the radiation pattern is other than vertical, the equipment should 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.

3.1.7.6.5

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, shall be published in accordance with the provisions of Annex 15.

3.1.7.6.5.1

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

3.1.7.6.5.2

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

3.1.7.6.5.3

The DME in 3.1.7.6.5 above shall conform to the specification in 3.5 below.

3.1.7.7 Monitoring

3.1.7.7.1

Suitable equipment shall provide signals for the operation of an automatic monitor. The monitor shall transmit a warning to a control point if either of the following conditions arise:

a) failure of the modulation or keying;

b) reduction of power output to less than 50 per cent of normal.

3.1.7.7.2

For each marker beacon, suitable monitoring equipment should be provided which will indicate at the appropriate location a decrease of the modulation depth below 50 per cent.

3.2 Specification for precision approach radar system

3.2.1

The precision approach radar system shall comprise the following elements:

3.2.1.1

The precision approach radar element (PAR).

3.2.1.2

The surveillance radar element (SRE).

3.2.2

When the PAR only is used, the installation shall be identified by the term PAR or precision approach radar and not by the term “precision approach radar system”.

3.2.3 The precision approach radar element (PAR)

3.2.3.1 Coverage

3.2.3.1.1

The PAR shall be capable of detecting and indicating the position of an aircraft of 15 m2 echoing area or larger, which is within a space bounded by a 20-degree azimuth sector and a 7-degree elevation sector, to a distance of at least 16.7 km (9 NM) from its respective antenna.

3.2.3.2 Siting

3.2.3.2.1

The PAR shall be sited and adjusted so that it gives complete coverage of a sector with its apex at a point 150 m (500 ft) from the touchdown in the direction of the stop end of the runway and extending plus or minus 5 degrees about the runway centre line in azimuth and from minus 1 degree to plus 6 degrees in elevation.

3.2.3.3 Accuracy

3.2.3.3.1

Azimuth accuracy. Azimuth information shall be displayed in such a manner that left-right deviation from the on-course line shall be easily observable. The maximum permissible error with respect to the deviation from the on-course line shall be either 0.6 per cent of the distance from the PAR antenna plus 10 per cent of the deviation from the on-course line or 9 m (30 ft), whichever is greater. The equipment shall be so sited that the error at the touchdown shall not exceed 9 m (30 ft). The equipment shall be so aligned and adjusted that the displayed error at the touchdown shall be a minimum and shall not exceed 0.3 per cent of the distance from the PAR antenna or 4.5 m (15 ft), whichever is greater. It shall be possible to resolve the positions of two aircraft which are at 1.2 degrees in azimuth of one another.

3.2.3.3.2

Elevation accuracy. Elevation information shall be displayed in such a manner that up-down deviation from the descent path for which the equipment is set shall be easily observable. The maximum permissible error with respect to the deviation from the on-course line shall be 0.4 per cent of the distance from the PAR antenna plus 10 per cent of the actual linear displacement from the chosen descent path or 6 m (20 ft), whichever is greater. The equipment shall be so sited that the error at the touchdown shall not exceed 6 m (20 ft). The equipment shall be so aligned and adjusted that the displayed error at the touchdown shall be a minimum and shall not exceed 0.2 per cent of the distance from the PAR antenna or 3 m (10 ft), whichever is greater. It shall be possible to resolve the positions of two aircraft that are at 0.6 degree in elevation of one another.

3.2.3.3.3

Distance accuracy. The error in indication of the distance from the touchdown shall not exceed 30 m (100 ft) plus 3 per cent of the distance from the touchdown. It shall be possible to resolve the positions of two aircraft which are at 120 m (400 ft) of one another on the same azimuth.

3.2.3.4

Information shall be made available to permit the position of the controlled aircraft to be established with respect to other aircraft and obstructions. Indications shall also permit appreciation of ground speed and rate of departure from or approach to the desired flight path.

3.2.3.5

Information shall be completely renewed at least once every second.

3.2.4 The surveillance radar element (SRE)

3.2.4.1

A surveillance radar used as the SRE of a precision approach radar system shall satisfy at least the following broad performance requirements.

3.2.4.2 Coverage

3.2.4.2.1

The SRE shall be capable of detecting aircraft of 15 m2 echoing area and larger, which are in line of sight of the antenna within a volume described as follows:

The rotation through 360 degrees about the antenna of a vertical plane surface bounded by a line at an angle of 1.5 degrees above the horizontal plane of the antenna, extending from the antenna to 37 km (20 NM); by a vertical line at 37 km (20 NM) from the intersection with the 1.5-degree line up to 2 400 m (8 000 ft) above the level of the antenna; by a horizontal line at 2 400 m (8 000 ft) from 37 km (20 NM) back towards the antenna to the intersection with a line from the antenna at 20 degrees above the horizontal plane of the antenna, and by a 20-degree line from the intersection with the 2 400 m (8 000 ft) line to the antenna.

3.2.4.2.2

Efforts should be made in development to increase the coverage on an aircraft of 15 m2 echoing area to at least the volume obtained by amending 3.2.4.2.1 above with the following substitutions:

for 1.5 degrees, read 0.5 degree;

for 37 km (20 NM), read 46.3 km (25 NM);

for 2 400 m (8 000 ft), read 3 000 m (10 000 ft);

for 20 degrees, read 30 degrees.

3.2.4.3 Accuracy

3.2.4.3.1

Azimuth accuracy. The indication of position in azimuth shall be within plus or minus 2 degrees of the true position. It shall be possible to resolve the positions of two aircraft which are at 4 degrees of azimuth of one another.

3.2.4.3.2

Distance accuracy. The error in distance indication shall not exceed 5 per cent of true distance or 150 m, whichever is the greater. It shall be possible to resolve the positions of two aircraft that are separated by a distance of 1 per cent of the true distance from the point of observation or 230 m, whichever is the greater.

3.2.4.3.2.1

The error in distance indication should not exceed 3 per cent of the true distance or 150 m, whichever is the greater.

3.2.4.4

The equipment shall be capable of completely renewing the information concerning the distance and azimuth of any aircraft within the coverage of the equipment at least once every 4 seconds.

3.2.4.5

Efforts should be made to reduce, as far as possible, the disturbance caused by ground echoes or echoes from clouds and precipitation.

3.3 Specification for VHF omnidirectional radio range (VOR)

3.3.1 General

3.3.1.1

The VOR shall be constructed and adjusted so that similar instrumental indications in aircraft represent equal clockwise angular deviations (bearings), degree for degree from magnetic North as measured from the location of the VOR.

3.3.1.2

The VOR shall radiate a radio frequency carrier with which are associated two separate 30 Hz modulations. One of these modulations shall be such that its phase is independent of the azimuth of the point of observation (reference phase). The other modulation (variable phase) shall be such that its phase at the point of observation differs from that of the reference phase by an angle equal to the bearing of the point of observation with respect to the VOR.

3.3.1.3

The reference and variable phase modulations shall be in phase along the reference meridian through the station.

3.3.2 Radio frequency

3.3.2.1

The VOR shall operate in the band 111.975 MHz to 117.975 MHz except that frequencies in the band 108 MHz to 111.975 MHz may be used when, in accordance with the provisions of Volume V, Chapter 4, 4.2.1 and 4.2.3.1, the use of such frequencies is acceptable. The highest assignable frequency shall be 117.950 MHz. The channel separation shall be in increments of 50 kHz referred to the highest assignable frequency. In areas where 100 kHz or 200 kHz channel spacing is in general use, the frequency tolerance of the radio frequency carrier shall be plus or minus 0.005 per cent.

3.3.2.2

The frequency tolerance of the radio frequency carrier of all new installations implemented after 23 May 1974 in areas where 50 kHz channel spacing is in use shall be plus or minus 0.002 per cent.

3.3.2.3

In areas where new VOR installations are implemented and are assigned frequencies spaced at 50 kHz from existing VORs in the same area, priority shall be given to ensuring that the frequency tolerance of the radio frequency carrier of the existing VORs is reduced to plus or minus 0.002 per cent.

3.3.3 Polarization and pattern accuracy

3.3.3.1

The emission from the VOR shall be horizontally polarized. The vertically polarized component of the radiation shall be as small as possible

3.3.3.2

The accuracy of the bearing information conveyed by the horizontally polarized radiation from the VOR at a distance of approximately four wavelengths for all elevation angles between 0 and 40 degrees, measured from the centre of the VOR antenna system, shall be within plus or minus 2 degrees.

3.3.4 Coverage

3.3.4.1

The VOR shall provide signals such as to permit satisfactory operation of a typical aircraft installation at the levels and distances required for operational reasons, and up to an elevation angle of 40 degrees.

3.3.4.2

The field strength or power density in space of VOR signals required to permit satisfactory operation of a typical aircraft installation at the minimum service level at the maximum specified service radius should be 90 microvolts per metre or minus 107 dBW/m2.

3.3.5 Modulations of navigational signals

3.3.5.1

The radio frequency carrier as observed at any point in space shall be amplitude modulated by two signals as follows:

a) a subcarrier of 9 960 Hz of constant amplitude, frequency modulated at 30 Hz and having a deviation ratio of 16 plus or minus 1 (i.e. 15 to 17):

1) for the conventional VOR, the 30 Hz component of this FM subcarrier is fixed without respect to azimuth and is termed the “reference phase”;

2) for the Doppler VOR, the phase of the 30 Hz component varies with azimuth and is termed the “variable phase”;

b) a 30 Hz amplitude modulation component:

1) for the conventional VOR, this component results from a rotating field pattern, the phase of which varies with azimuth, and is termed the “variable phase”;

2) for the Doppler VOR, this component, of constant phase with relation to azimuth and constant amplitude, is radiated omnidirectionally and is termed the “reference phase”.

3.3.5.2

The depth of modulation of the radio frequency carrier due to the subcarrier of 9 960 Hz shall be within the limits of 28 per cent and 32 per cent.

3.3.5.3

The depth of modulation of the radio frequency carrier due to the 30 Hz or 9 960 Hz signals, as observed at any angle of elevation up to 5 degrees, shall be within the limits of 28 to 32 per cent.

3.3.5.4

The variable and reference phase modulation frequencies shall be 30 Hz within plus or minus 1 per cent.

3.3.5.5

The subcarrier modulation mid-frequency shall be 9 960 Hz within plus or minus 1 per cent.

3.3.5.6

a) For the conventional VOR, the percentage of amplitude modulation of the 9 960 Hz subcarrier shall not exceed 5 per cent.

b) For the Doppler VOR, the percentage of amplitude modulation of the 9 960 Hz subcarrier shall not exceed 40 per cent when measured at a point at least 300 m (1 000 ft) from the VOR.

3.3.5.7

Where 50 kHz VOR channel spacing is implemented, the sideband level of the harmonics of the 9 960 Hz component in the radiated signal shall not exceed the following levels referred to the level of the 9 960 Hz sideband:

Subcarrier	Level
9 960 Hz	0 dB reference
2nd harmonic	-30 dB
3rd harmonic	-50 dB
4th harmonic and above	-60 dB

3.3.6 Voice and identification

3.3.6.1

If the VOR provides a simultaneous communication channel ground-to-air, it shall be on the same radio frequency carrier as used for the navigational function. The radiation on this channel shall be horizontally polarized.

3.3.6.2

The peak modulation depth of the carrier on the communication channel shall not be greater than 30 per cent.

3.3.6.3

The audio frequency characteristics of the speech channel shall be within 3 dB relative to the level at 1 000 Hz over the range 300 Hz to 3 000 Hz.

3.3.6.4

The VOR shall provide for the simultaneous transmission of a signal of identification on the same radio frequency carrier as that used for the navigational function. The identification signal radiation shall be horizontally polarized.

3.3.6.5

The identification signal shall employ the International Morse Code and consist of two or three letters. It shall be sent at a speed corresponding to approximately 7 words per minute. The signal shall be repeated at least once every 30 seconds and the modulation tone shall be 1 020 Hz within plus or minus 50 Hz.

3.3.6.5.1

The identification signal should be transmitted at least three times each 30 seconds, spaced equally within that time period. One of these identification signals may take the form of a voice identification.

3.3.6.6

The depth to which the radio frequency carrier is modulated by the code identification signal shall be close to, but not in excess of 10 per cent except that, where a communication channel is not provided, it shall be permissible to increase the modulation by the code identification signal to a value not exceeding 20 per cent.

3.3.6.6.1

If the VOR provides a simultaneous communication channel ground-to-air, the modulation depth of the code identification signal should be 5 plus or minus 1 per cent in order to provide a satisfactory voice quality.

3.3.6.7

The transmission of speech shall not interfere in any way with the basic navigational function. When speech is being radiated, the code identification shall not be suppressed.

3.3.6.8

The VOR receiving function shall permit positive identification of the wanted signal under the signal conditions encountered within the specified coverage limits, and with the modulation parameters specified at 3.3.6.5, 3.3.6.6 and 3.3.6.7 above.

3.3.7 Monitoring

3.3.7.1

Suitable equipment located in the radiation field shall provide signals for the operation of an automatic monitor. The monitor shall transmit a warning to a control point, and either remove the identification and navigation components from the carrier or cause radiation to cease if any one or a combination of the following deviations from established conditions arises:

a) a change in excess of 1 degree at the monitor site of the bearing information transmitted by the VOR;

b) a reduction of 15 per cent in the modulation components of the radio frequency signals voltage level at the monitor of either the subcarrier, or 30 Hz amplitude modulation signals, or both.

3.3.7.2

Failure of the monitor itself shall transmit a warning to a control point and either:

a) remove the identification and navigation components from the carrier; or

b) cause radiation to cease.

3.3.8 Interference immunity performance for VOR receiving systems

Difference:- Not a mandatory requirement for VOR receiving systems fitted to New Zealand registered aircraft.

3.3.8.1

After 1 January 1998, the VOR receiving system shall provide adequate immunity to interference from two signal, third-order intermodulation products caused by VHF FM broadcast signals having levels in accordance with the following:

(See Annex for formula)

for VHF FM sound broadcasting signals in the range 107.7 - 108.0 MHz and

(See Annex for formula)

for VHF FM sound broadcasting signals below 107.7 MHz,

where the frequencies of the two VHF FM sound broadcasting signals produce, within the receiver, a two signal, third-order intermodulation product on the desired VOR frequency.

N1 and N2 are the levels (dBm) of the two VHF FM sound broadcasting signals at the VOR receiver input. Neither level shall exceed the desensitization criteria set forth in 3.3.8.2 below.

f = 108.1 - f1, where f1 is the frequency of N1, the VHF FM sound broadcasting signal closer to 108.1 MHz.

3.3.8.2

After 1 January 1998, the VOR receiving system shall not be desensitized in the presence of VHF FM broadcast signals having levels in accordance with the following table:

Frequency (MHz)	Maximum level of unwanted signal at receiver input
88-102	+15 dBm
104	+10 dBm
106	+ 5 dBm
107.9	-10 dBm

3.3.8.3

After 1 January 1995, all new installations of airborne VOR receiving systems shall meet the provisions of 3.3.8.1 and 3.3.8.2 above.

3.3.8.4

Airborne VOR receiving systems meeting the immunity performance standards of 3.3.8.1 and 3.3.8.2 above should be placed into operation at the earliest possible date.

3.4. Specification for non-directional radio beacon (NDB)

3.4.1 Definitions

Average radius of rated coverage. The radius of a circle having the same area as the rated coverage.

Effective coverage. The area surrounding an NDB within which bearings can be obtained with an accuracy sufficient for the nature of the operation concerned.

Locator. An LF/MF NDB used as an aid to final approach.

Rated coverage. The area surrounding an NDB within which the strength of the vertical field of the ground wave exceeds the minimum value specified for the geographical area in which the radio beacon is situated.

3.4.2 Coverage

3.4.2.1

The minimum value of field strength in the rated coverage of an NDB should be 70 micro-volts per metre.

3.4.2.2

All notifications or promulgations of NDBs shall be based upon the average radius of the rated coverage.

3.4.2.3

Where the rated coverage of an NDB is materially different in various operationally significant sectors, its classification should be expressed in terms of the average radius of rated coverage and the angular limits of each sector as follows:

Radius of coverage of sector/angular limits of sector expressed as magnetic bearing clockwise from the beacon.

Where it is desirable to classify an NDB in such a manner, the number of sectors should be kept to a minimum and preferably should not exceed two.

3.4.3 Limitations in radiated power

The power radiated from an NDB shall not exceed by more than 2 dB that necessary to achieve its agreed rated coverage, except that this power may be increased if coordinated regionally or if no harmful interference to other facilities will result.

3.4.4 Radio frequencies

3.4.4.1

The radio frequencies assigned to NDBs shall be selected from those available in that portion of the spectrum between 190 kHz and 1 750 kHz.

3.4.4.2

The frequency tolerance applicable to NDBs shall be 0.01 per cent except that, for NDBs of antenna power above 200 W using frequencies of 1 606.5 kHz and above, the tolerance shall be 0.005 per cent.

3.4.4.3

Where two locators are used as supplements to an ILS, the frequency separation between the carriers of the two should be not less than 15 kHz to ensure correct operation of the radio compass, and preferably not more than 25 kHz in order to permit a quick tuning shift in cases where an aircraft has only one radio compass.

3.4.4.4

Where locators associated with ILS facilities serving opposite ends of a single runway are assigned a common frequency, provision shall be made to ensure that the facility not in operational use cannot radiate.

3.4.5 Identification

3.4.5.1

Each NDB shall be individually identified by a two- or three-letter International Morse Code group transmitted at a rate corresponding to approximately 7 words per minute.

3.4.5.2

The complete identification shall be transmitted at least once every 30 seconds, except where the beacon identification is effected by on/off keying of the carrier. In this latter case, the identification shall be at approximately 1-minute intervals, except that a shorter interval may be used at particular NDB stations where this is found to be operationally desirable.

3.4.5.2.1

Except for those cases where the beacon identification is effected by on/off keying of the carrier, the identification signal should be transmitted at least three times each 30 seconds, spaced equally within that time period.

3.4.5.3

For NDBs with an average radius of rated coverage of 92.7 km (50 NM) or less that are primarily approach and holding aids in the vicinity of an aerodrome, the identification shall be transmitted at least three times each 30 seconds, spaced equally within that time period.

3.4.5.4

The frequency of the modulating tone used for identification shall be 1 020 Hz plus or minus 50 Hz or 400 Hz plus or minus 25 Hz.

3.4.6 Characteristics of emissions

3.4.6.1

Except as provided in 3.4.6.1.1, all NDBs shall radiate an uninterrupted carrier and be identified by on/off keying of an amplitude modulating tone (NON/A2A).

3.4.6.1.1

NDBs other than those wholly or partly serving as holding, approach and landing aids, or those having an average radius of rated coverage of less than 92.7 km (50 NM), may be identified by on/off keying of the unmodulated carrier (NON/A1A) if they are in areas of high beacon density and/or where the required rated coverage is not practicable of achievement because of:

a) radio interference from radio stations;

b) high atmospheric noise;

c) local conditions.

3.4.6.2

For each NDB identified by on/off keying of an audio modulating tone, the depth of modulation shall be maintained as near to 95 per cent as practicable.

3.4.6.3

For each NDB identified by on/off keying of an audio modulating tone, the characteristics of emission during identification shall be such as to ensure satisfactory identification at the limit of its rated coverage.

3.4.6.4

The carrier power of an NDB with NON/A2A emissions should not fall when the identity signal is being radiated except that, in the case of an NDB having an average radius of rated coverage exceeding 92.7 km (50 NM), a fall of not more than 1.5 dB may be accepted.

3.4.6.5

Unwanted audio frequency modulations shall total less than 5 per cent of the amplitude of the carrier.

3.4.6.6

The bandwidth of emissions and the level of spurious emissions shall be kept at the lowest value that the state of technique and the nature of the service permit.

3.4.7 Siting of locators

3.4.7.1

Where locators are used as a supplement to the ILS, they should be located at the sites of the outer and middle marker beacons. Where only one locator is used as a supplement to the ILS, preference should be given to location at the site of the outer marker beacon. Where locators are employed as an aid to final approach in the absence of an ILS, equivalent locations to those applying when an ILS is installed should be selected, taking into account the relevant obstacle clearance provisions of the Procedures for Air Navigation Services - Aircraft Operations (Doc 8168).

3.4.7.2

Where locators are installed at both the middle and outer marker positions, they should be located, where practicable, on the same side of the extended centre line of the runway in order to provide a track between the locators which will be more nearly parallel to the centre line of the runway.

3.4.8 Monitoring

3.4.8.1

For each NDB, suitable means shall be provided to enable detection of any of the following conditions at an appropriate location:

a) a decrease in radiated carrier power of more than 50 per cent below that required for the rated coverage;

b) failure to transmit the identification signal;

c) malfunctioning or failure of the means of monitoring itself.

3.4.8.2*

When an NDB is operated from a power source having a frequency which is close to airborne ADF equipment switching frequencies, and where the design of the NDB is such that the power supply frequency is likely to appear as a modulation product on the emission, the means of monitoring should be capable of detecting such power supply modulation on the carrier in excess of 5 per cent.

Difference:- Mandatory Standard.

3.4.8.3

During the hours of service of a locator, the means of monitoring shall provide for a continuous check on the functioning of the locator as prescribed in 3.4.8.1 a), b) and c) above

3.4.8.4*

During the hours of service of an NDB other than a locator, the means of monitoring should provide for a continuous check on the functioning of the NDB as prescribed in 3.4.8.1 a), b) and c).

Difference:- Mandatory Standard.

3.5 Specification for UHF distance measuring equipment (DME)

3.5.1 Definitions

Control motion noise (CMN). That portion of the guidance signal error which causes control surface, wheel and column motion and could affect aircraft attitude angle during coupled flight, but does not cause aircraft displacement from the desired course and/or glide path. (See 3.11 below.)

DME dead time. A period immediately following the decoding of a valid interrogation during which a received interrogation will not cause a reply to be generated.

DME/N. Distance measuring equipment, primarily serving operational needs of en-route or TMA navigation, where the “N” stands for narrow spectrum characteristics (to be distinguished from “W”).

DME/P. The distance measuring element of the MLS, where the “P” stands for precise distance measurement. The spectrum characteristics are those of DME/N.

Equivalent isotropically radiated power (e.i.r.p.). The product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain).

Final approach (FA) mode. The condition of DME/P operation which supports flight operations in the final approach and runway regions.

Initial approach (IA) mode. The condition of DME/P operation which supports those flight operations outside the final approach region and which is interoperable with DME/N.

Key down time. The time during which a dot or dash of a Morse character is being transmitted.

MLS approach reference datum. A point on the minimum glide path at a specified height above the threshold. (See 3.11 below.)

MLS datum point. The point on the runway centre line closest to the phase centre of the approach elevation antenna. (See 3.11 below.)

Mode W, X, Y, Z. A method of coding the DME transmissions by time spacing pulses of a pulse pair, so that each frequency can be used more than once.

Partial rise time. The time as measured between the 5 and 30 per cent amplitude points on the leading edge of the pulse envelope, i.e. between points h and i on Figures 3-1 and 3-2.

Path following error (PFE). That portion of the guidance signal error which could cause aircraft displacement from the desired course and/or glide path. (See 3.11 below.)

Pulse amplitude. The maximum voltage of the pulse envelope, i.e. A in Figure 3-1.

Pulse decay time. The time as measured between the 90 and 10 per cent amplitude points on the trailing edge of the pulse envelope, i.e. between points e and g on Figure 3-1.

Pulse code. The method of differentiating between W, X, Y and Z modes and between FA and IA modes.

Pulse duration. The time interval between the 50 per cent amplitude point on leading and trailing edges of the pulse envelope, i.e. between points b and f on Figure 3-1.

Pulse rise time. The time as measured between the 10 and 90 per cent amplitude points on the leading edge of the pulse envelope, i.e. between points a and c on Figure 3-1.

Reply efficiency. The ratio of replies transmitted by the transponder to the total of received valid interrogations.

Search. The condition which exists when the DME interrogator is attempting to acquire and lock onto the response to its own interrogations from the selected transponder.

System efficiency. The ratio of valid replies processed by the interrogator to the total of its own interrogations.

Track. The condition which exists when the DME interrogator has locked onto replies in response to its own interrogations, and is continuously providing a distance measurement.

Transmission rate. The average number of pulse pairs transmitted from the transponder per second.

Virtual origin. The point at which the straight line through the 30 per cent and 5 per cent amplitude points on the pulse leading edge intersects the 0 per cent amplitude axis (see Figure 3-2).

3.5.2 General

3.5.2.1

The DME system shall provide for continuous and accurate indication in the cockpit of the slant range distance of an equipped aircraft from an equipped ground reference point.

3.5.2.2

The system shall comprise two basic components, one fitted in the aircraft, the other installed on the ground. The aircraft component shall be referred to as the interrogator and the ground component as the transponder.

3.5.2.3

In operation, interrogators shall interrogate transponders which shall, in turn, transmit to the interrogator replies synchronized with the interrogations, thus providing means for accurate measurement of distance.

3.5.2.4

DME/P shall have two operating modes, IA and FA.

3.5.2.5

When a DME function is combined with either an ILS, MLS or VOR for the purpose of constituting a single facility, they shall be considered to be associated in a manner complying with Chapter 2, 2.2.2, only when:

a) operated on a standard frequency pairing in accordance with 3.5.3.3.5 below;

b) collocated within the limits prescribed for associated facilities in 3.5.2.6 below; and

c) complying with the identification provisions of 3.5.3.6.4 below.

3.5.2.6 Collocation limits for a DME facility associated with an ILS, MLS or VOR facility

3.5.2.6.1

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

a) coaxial collocation: the VOR and DME antennas are located on the same vertical axis; or

b) offset collocation:

1) for those facilities used in terminal areas for approach purposes or other procedures where the highest position fixing accuracy of system capability is required, the separation of the VOR and DME antennas does not exceed 30 m (100 ft) except that, at Doppler VOR facilities, where DME service is provided by a separate facility, the antennas may be separated by more than 30 m (100 ft), but not in excess of 80 m (260 ft);

2) for purposes other than those indicated in 1), the separation of the VOR and DME antennas does not exceed 600 m (2 000 ft).

3.5.2.6.2 Association of DME with ILS

3.5.2.6.3 Association of DME with MLS

3.5.2.6.3.1

If a DME/P is used to provide ranging information, it should be sited as close as possible to the MLS azimuth facility.

3.5.3 System characteristics

3.5.3.1 Performance

3.5.3.1.1 Range.

The system shall provide a means of measurement of slant range distance from an aircraft to a selected transponder to the limit of coverage prescribed by the operational requirements for the selected transponder.

3.5.3.1.2 Coverage

3.5.3.1.2.1

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

3.5.3.1.2.2

When associated with either an ILS or an MLS, DME/N coverage shall be at least that of the respective ILS or of the MLS azimuth angle guidance coverage sectors.

3.5.3.1.2.3

DME/P coverage shall be at least that provided by the MLS azimuth angle guidance coverage sectors.

3.5.3.1.3 Accuracy

3.5.3.1.3.1 System accuracy

The accuracy standards specified herein shall be met on a 95 per cent probability basis.

3.5.3.1.3.2

At distances of from zero to 370 km (200 NM) from the transponder, dependent upon the particular service application, the total system error, excluding reading error, should be not greater than plus or minus 460 m (0.25 NM) plus 1.25 per cent of distance measured.

3.5.3.1.3.3

‡ The total system error shall not exceed plus or minus 370 m (0.2 NM).

3.5.3.1.3.4 DME/P accuracy

3.5.3.1.3.4.1

Error components. The path following error (PFE) shall be comprised of those frequency components of the DME/P error at the output of the interrogator which lie below 1.5 rad/s. The control motion noise (CMN) shall be comprised of those frequency components of the DME/P error at the output of the interrogator which lie between 0.5 rad/s and 10 rad/s.

3.5.3.1.3.4.2

Errors on the extended runway centre line shall not exceed the values given in Table B at the end of this chapter.

3.5.3.1.3.4.3

In the approach sector, away from the extended runway centre line, the allowable PFE for both standard 1 and standard 2 shall be permitted to increase linearly with angle up to plus or minus 40 degrees MLS azimuth angle where the permitted error is 1.5 times that on the extended runway centre line at the same distance. The allowable CMN shall not increase with angle. There shall be no degradation of either PFE or CMN with elevation angle.

3.5.3.2 Radio frequencies and polarization.

The system shall operate with vertical polarization in the frequency band 960 MHz to 1 215 MHz. The interrogation and reply frequencies shall be assigned with 1-MHz spacing between channels.

3.5.3.3 Channelling

3.5.3.3.1

DME operating channels shall be formed by pairing interrogation and reply frequencies and by pulse coding on the paired frequencies.

3.5.3.3.2

Pulse coding. DME/P channels shall have two different interrogation pulse codes as shown in the table of 3.5.4.4.1. One shall be used in the initial approach (IA) mode; the other shall be used in the final approach (FA) mode.

3.5.3.3.3

DME operating channels shall be chosen from Table A (located at the end of this chapter), of 352 channels in which the channel numbers, frequencies, and pulse codes are assigned.

3.5.3.3.4 Area channel assignment

3.5.3.3.4.1

In a particular area, the number of DME operating channels to be used shall be decided regionally.

3.5.3.3.4.2

The specific DME operating channels to be assigned in such a particular area shall also be decided regionally, taking into consideration the requirements for co-channel and adjacent channel protection.

3.5.3.3.4.3

Co-ordination of regional DME channel assignments should be effected through ICAO.

3.5.3.3.5 Channel pairing

When a DME transponder is intended to operate in association with a single VHF navigation facility in the 108 MHz to 117.95 MHz frequency band and/or an MLS angle facility in the 5 031.0 MHz to 5 090.7 MHz frequency band, the DME operating channel shall be paired with the VHF channel and/or MLS angle frequency as given in Table A.

3.5.3.4 Interrogation pulse repetition frequency

3.5.3.4.1

DME/N. The interrogator average pulse repetition frequency (PRF) shall not exceed 30 pairs of pulses per second, based on the assumption that at least 95 per cent of the time is occupied for tracking.

3.5.3.4.2

DME/N. If it is desired to decrease the time of search, the PRF may be increased during search but shall not exceed 150 pairs of pulses per second.

3.5.3.4.3

After 15 000 pairs of pulses have been transmitted without acquiring indication of distance, the PRF should not exceed 60 pairs of pulses per second thereafter, until a change in operating channel is made or successful search is completed.

3.5.3.4.4

‡ DME/N. When, after a time period of 30 seconds, tracking has not been established the pulse pair repetition frequency shall not exceed 30 pulse pairs per second thereafter.

3.5.3.4.5

DME/P. The interrogator pulse repetition frequency shall not exceed the following number of pulse pairs per second:

a) search 40

b) aircraft on the ground 5

c) initial approach mode track 16

d) final approach mode track 40

3.5.3.5 Aircraft handling capacity of the system

3.5.3.5.1

The aircraft handling capacity of transponders in an area shall be adequate for the peak traffic of the area or 100 aircraft, whichever is the lesser.

3.5.3.5.2

Where the peak traffic in an area exceeds 100 aircraft, the transponder should be capable of handling that peak traffic.

3.5.3.6 Transponder identification

3.5.3.6.1

All transponders shall transmit an identification signal in one of the following forms as required by 3.5.3.6.5 below:

a) an “independent” identification consisting of coded (International Morse Code) identity pulses which can be used with all transponders;

b) an “associated” signal which can be used for transponders specifically associated with a VHF navigation or an MLS angle guidance facility which itself transmits an identification signal.

3.5.3.6.2

Both systems of identification shall use signals, which shall consist of the transmission for an appropriate period of a series of paired pulses transmitted at a repetition rate of 1 350 pulse pairs per second, and shall temporarily replace all reply pulses that would normally occur at that time except as in 3.5.3.6.2.2 below. These pulses shall have similar characteristics to the other pulses of the reply signals.

3.5.3.6.2.1

‡ DME/N. Reply pulses shall be transmitted between key down times.

3.5.3.6.2.2

DME/N. If it is desired to preserve a constant duty cycle, an equalizing pair of pulses, having the same characteristics as the identification pulse pairs, should be transmitted 100 microseconds plus or minus 10 microseconds after each identity pair.

3.5.3.6.2.3

DME/P. Reply pulses shall be transmitted between key down times.

3.5.3.6.2.4

For the DME/P transponder, reply pulse pairs to valid FA mode interrogations shall also be transmitted during key down times and have priority over identification pulse pairs.

3.5.3.6.2.5

The DME/P transponder shall not employ the equalizing pair of pulses of 3.5.3.6.2.2 above.

3.5.3.6.3

The characteristics of the “independent” identification signal shall be as follows:

a) the identity signal shall consist of the transmission of the beacon code in the form of dots and dashes (International Morse Code) of identity pulses at least once every 40 seconds, at a rate of at least 6 words per minute; and

Difference:- The beacon identity code signal must be transmitted at least once but not more than twice every 40 seconds with code groups equally spaced.

b) the identification code characteristic and letter rate for the DME transponder shall conform to the following to ensure that the maximum total key down time does not exceed 5 seconds per identification code group. The dots shall be a time duration of 0.1 second to 0.160 second. The dashes shall be typically 3 times the duration of the dots. The duration between dots and/or dashes shall be equal to that of one dot plus or minus 10 per cent. The time duration between letters or numerals shall not be less than three dots. The total period for transmission of an identification code group shall not exceed 10 seconds.

3.5.3.6.4

The characteristics of the "associated" signal shall be as follows:

a) when associated with a VHF or an MLS angle facility, the identification shall be transmitted in the form of dots and dashes (International Morse Code) as in 3.5.3.6.3 above and shall be synchronized with the VHF facility identification code;

b) each 40-second interval shall be divided into four or more equal periods, with the transponder identification transmitted during one period only and the associated VHF and MLS angle facility identification, where these are provided, transmitted during the remaining periods;

c) for a DME transponder associated with an MLS, the identification shall be the last three letters of the MLS angle facility identification specified in 3.11.4.6.2.1 below.

3.5.3.6.5 Identification implementation

3.5.3.6.5.1

The "independent" identification code shall be employed wherever a transponder is not specifically associated with a VHF navigational facility or an MLS facility.

3.5.3.6.5.2

Wherever a transponder is specifically associated with a VHF navigational facility or an MLS facility, identification shall be provided by the "associated" code.

3.5.3.6.5.3

When voice communications are being radiated on an associated VHF navigational facility, an "associated" signal from the transponder shall not be suppressed.

3.5.3.7 DME/P mode transition

3.5.3.7.1

The DME/P interrogator for Standard 1 accuracy shall change from IA mode track to FA mode track at 13 km (7 NM) from the transponder when approaching the transponder, or any other situation when within 13 km (7 NM).

3.5.3.7.2

For Standard 1 accuracy, the transition from IA mode to FA mode track operation may be initiated within 14.8 km (8 NM) from the transponder. Outside 14.8 km (8 NM), the interrogator shall not interrogate in the FA mode.

3.5.3.8 System efficiency

The DME/P system accuracy of 3.5.3.1.3.4 above shall be achieved with a system efficiency of 50 per cent or more.

3.5.4 Detailed technical characteristics of transponder and associated monitor

3.5.4.1 Transmitter

3.5.4.1.1

Frequency of operation. The transponder shall transmit on the reply frequency appropriate to the assigned DME channel (see 3.5.3.3.3 above).

3.5.4.1.2

Frequency stability. The radio frequency of operation shall not vary more than plus or minus 0.002 per cent from the assigned frequency.

3.5.4.1.3

Pulse shape and spectrum. The following shall apply to all radiated pulses:

a) Pulse rise time.

1) DME/N. Pulse rise time shall not exceed 3 micro-seconds.

2) DME/P. Pulse rise time shall not exceed 1.6 microseconds. For the FA mode, the pulse shall have a partial rise time of 0.25 plus or minus 0.05 microsecond. With respect to the FA mode and accuracy standard 1, the slope of the pulse in the partial rise time shall not vary by more than plus or minus 20 per cent. For accuracy standard 2, the slope shall not vary by more than plus or minus 10 per cent.

3) DME/P. Recommendation.- Pulse rise time should not exceed 1.2 microseconds.

b) Pulse duration shall be 3.5 microseconds plus or minus 0.5 microsecond.

c) Pulse decay time shall nominally be 2.5 microseconds but shall not exceed 3.5 microseconds.

d) The instantaneous amplitude of the pulse shall not, at any instant between the point of the leading edge which is 95 per cent of maximum amplitude and the point of the trailing edge which is 95 per cent of the maximum amplitude, fall below a value which is 95 per cent of the maximum voltage amplitude of the pulse.

e) For DME/N and DME/P: the spectrum of the pulse modulated signal shall be such that during the pulse the effective radiated power contained in a 0.5 MHz band centred on frequencies 0.8 MHz above and 0.8 MHz below the nominal channel frequency in each case shall not exceed 200 mW, and the effective radiated power contained in a 0.5 MHz band centred on frequencies 2 MHz above and 2 MHz below the nominal channel frequency in each case shall not exceed 2 mW. The effective radiated power contained within any 0.5 MHz band shall decrease monotonically as the band centre frequency moves away from the nominal channel frequency.

f) To ensure proper operation of the thresholding techniques, the instantaneous magnitude of any pulse turn-on transients which occur in time prior to the virtual origin shall be less than one per cent of the pulse peak amplitude. Initiation of the turn-on process shall not commence sooner than 1 microsecond prior to the virtual origin.

3.5.4.1.4 Pulse spacing

3.5.4.1.4.1

The spacing of the constituent pulses of transmitted pulse pairs shall be as given in the table in 3.5.4.4.1.

3.5.4.1.4.2

DME/N. The tolerance on the pulse spacing shall be plus or minus 0.25 microsecond.

3.5.4.1.4.3

DME/N. - The tolerance on the DME/N pulse spacing should be plus or minus 0.10 microsecond.

3.5.4.1.4.4

DME/P. The tolerance on the pulse spacing shall be plus or minus 0.10 microsecond.

3.5.4.1.4.5

The pulse spacings shall be measured between the half voltage points on the leading edges of the pulses.

3.5.4.1.5 Peak power output

3.5.4.1.5.1

DME/N. The peak effective radiated power should not be less than that required to ensure a peak pulse power density of approximately minus 83 dBW/m2 at the maximum specified service range and level.

3.5.4.1.5.2

‡ DME/N. The peak equivalent isotropically radiated power shall not be less than that required to ensure a peak pulse power density of minus 89 dBW/m2 under all operational weather conditions at any point within coverage specified in 3.5.3.1.2 above.

3.5.4.1.5.3

DME/P. The peak equivalent isotropically radiated power shall not be less than that required to ensure the following peak pulse power densities under all operational weather conditions:

a) minus 89 dBW/m2 at any point within the coverage specified in 3.5.3.1.2 above at ranges greater than 13 km (7 NM) from the transponder antenna;

b) minus 75 dBW/m2 at any point within the coverage specified in 3.5.3.1.2 above at ranges less than 13 km (7 NM) from the transponder antenna;

c) minus 70 dBW/m2 at the MLS approach reference datum;

d) minus 79 dBW/m2 at 2.5 m (8 ft) above the runway surface, at the MLS datum point, or at the farthest point on the runway centre line which is in line of sight of the DME transponder antenna.

3.5.4.1.5.4

The peak power of the constituent pulses of any pair of pulses shall not differ by more than 1 dB.

3.5.4.1.5.5

The reply capability of the transmitter should be such that the transponder should be capable of continuous operation at a transmission rate of 2 700 plus or minus 90 pulse pairs per second (if 100 aircraft are to be served).

3.5.4.1.5.6

The transmitter shall operate at a trans-mission rate, including randomly distributed pulse pairs and distance reply pulse pairs, of not less than 700 pulse pairs per second except during identity. The minimum transmission rate shall be as close as practicable to 700 pulse pairs per second. For DME/P, in no case shall it exceed 1 200 pulse pairs per second.

3.5.4.1.6 Spurious radiation.

During intervals between transmission of individual pulses, the spurious power received and measured in a receiver having the same characteristics as a transponder receiver, but tuned to any DME interrogation or reply frequency, shall be more than 50 dB below the peak pulse power received and measured in the same receiver tuned to the reply frequency in use during the transmission of the required pulses. This provision refers to all spurious trans-missions, including modulator and electrical interference.

3.5.4.1.6.1

‡ DME/N. The spurious power level specified in 3.5.4.1.6 above shall be more than 80 dB below the peak pulse power level.

3.5.4.1.6.2

DME/P. The spurious power level specified in 3.5.4.1.6 above shall be more than 80 dB below the peak pulse power level.

3.5.4.1.6.3

Out-of-band spurious radiation. At all frequencies from 10 to 1 800 MHz, but excluding the band of frequencies from 960 to 1 215 MHz, the spurious output of the DME transponder transmitter shall not exceed minus 40 dBm in any one kHz of receiver bandwidth.

3.5.4.1.6.4

The equivalent isotropically radiated power of any CW harmonic of the carrier frequency on any DME operating channel shall not exceed minus 10 dBm.

3.5.4.2 Receiver

3.5.4.2.1

Frequency of operation. The receiver centre frequency shall be the interrogation frequency appropriate to the assigned DME operating channel (see 3.5.3.3.3 above).

3.5.4.2.2

Frequency stability. The centre frequency of the receiver shall not vary more than plus or minus 0.002 per cent from the assigned frequency.

3.5.4.3 Transponder sensitivity

3.5.4.2.3.1

In the absence of all interrogation pulse pairs, with the exception of those necessary to perform the sensitivity measurement, interrogation pulse pairs with the correct spacing and nominal frequency shall trigger the transponder if the peak power density at the transponder antenna is at least:

a) minus 103 dBW/m2 for DME/N;

b) minus 86 dBW/m2 for DME/P IA mode;

c) minus 75 dBW/m2 for DME/P FA mode.

3.5.4.2.3.2

The minimum power densities specified in 3.5.4.2.3.1 above shall cause the transponder to reply with an efficiency of at least:

a) 70 per cent for DME/N;

b) 70 per cent for DME/P IA mode;

c) 80 per cent for DME/P FA mode.

3.5.4.2.3.3

‡ DME/N dynamic range. The performance of the transponder shall be maintained when the power density of the interrogation signal at the transponder antenna has any value between the minimum specified in 3.5.4.2.3.1 above up to a maximum of minus 22 dBW/m2 when installed with ILS or MLS and minus 35 dBW/m2 when installed for other applications.

3.5.4.2.3.4

DME/P dynamic range. The performance of the transponder shall be maintained when the power density of the interrogation signal at the transponder antenna has any value between the minimum specified in 3.5.4.2.3.1 above up to a maximum of minus 22 dBW/m2.

3.5.4.2.3.5

The transponder sensitivity level shall not vary by more than 1 dB for transponder loadings between 0 and 90 per cent of its maximum transmission rate.

3.5.4.2.3.6

‡ DME/N. When the spacing of an interrogator pulse pair varies from the nominal value by up to plus or minus 1 microsecond, the receiver sensitivity shall not be reduced by more than 1 dB.

3.5.4.2.3.7

DME/P. When the spacing of an interrogator pulse pair varies from the nominal value by up to plus or minus 1 microsecond, the receiver sensitivity shall not be reduced by more than 1 dB.

3.5.4.2.4 Load limiting

3.5.4.2.4.1

DME/N. When transponder loading exceeds 90 per cent of the maximum transmission rate, the receiver sensitivity should be automatically reduced in order to limit the transponder replies, so as to ensure that the maximum permissible transmission rate is not exceeded. (The available range of sensitivity reduction should be at least 50 dB.)

3.5.4.2.4.2

DME/P. To prevent transponder overloading the transponder shall automatically limit its replies, so as to ensure that the maximum transmission rate is not exceeded. If the receiver sensitivity reduction is implemented to meet this requirement, it shall be applied to the IA mode only and shall not affect the FA mode.

3.5.4.2.5 Noise

When the receiver is interrogated at the power densities specified in 3.5.4.2.3.1 above to produce a transmission rate equal to 90 per cent of the maximum, the noise generated pulse pairs shall not exceed 5 per cent of the maximum transmission rate.

3.5.4.2.6 Bandwidth

3.5.4.2.6.1

The minimum permissible bandwidth of the receiver shall be such that the transponder sensitivity level shall not deteriorate by more than 3 dB when the total receiver drift is added to an incoming interrogation frequency drift of plus or minus 100 kHz.

3.5.4.2.6.2

DME/N. The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 above when the input signals are those specified in 3.5.5.1.3 below.

3.5.4.2.6.3

DME/P - IA mode. The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 above when the input signals are those specified in 3.5.5.1.3 below. The 12 dB bandwidth shall not exceed 2 MHz and the 60 dB bandwidth shall not exceed 10 MHz.

3.5.4.2.6.4

DME/P - FA mode. The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 above when the input signals are those specified in 3.5.5.1.3 below. The 12 dB bandwidth shall not exceed 6 MHz and the 60 dB bandwidth shall not exceed 20 MHz.

3.5.4.2.6.5

Signals greater than 900 kHz removed from the desired channel nominal frequency and having power densities up to the values specified in 3.5.4.2.3.3 for DME/N and 3.5.4.2.3.4 for DME/P shall not trigger the transponder. Signals arriving at the intermediate frequency shall be suppressed at least 80 dB. All other spurious response or signals within the 960 MHz to 1 215 MHz band and image frequencies shall be suppressed at least 75 dB.

3.5.4.2.7

Recovery time. Within 8 microseconds of the reception of a signal between 0 dB and 60 dB above minimum sensitivity level, the minimum sensitivity level of the transponder to a desired signal shall be within 3 dB of the value obtained in the absence of signals. This requirement shall be met with echo suppression circuits, if any, rendered inoperative. The 8 microseconds are to be measured between the half voltage points on the leading edges of the two signals, both of which conform in shape, with the specifications in 3.5.5.1.3 below.

3.5.4.2.8

Spurious radiations. Radiation from any part of the receiver or allied circuits shall meet the requirements stated in 3.5.4.1.6 above.

3.5.4.2.9 CW and echo suppression

CW and echo suppression should be adequate for the sites at which the transponders will be used.

3.5.4.2.10 Protection against interference

Protection against interference outside the DME frequency band should be adequate for the sites at which the transponders will be used.

3.5.4.3 Decoding

3.5.4.3.1

The transponder shall include a decoding circuit such that the transponder can be triggered only by pairs of received pulses having pulse duration and pulse spacings appropriate to interrogator signals as described in 3.5.5.1.3 and 3.5.5.1.4 below.

3.5.4.3.2

The decoding circuit performance shall not be affected by signals arriving before, between, or after, the constituent pulses of a pair of the correct spacing.

3.5.4.3.3

‡ DME/N - Decoder rejection. An interrogation pulse pair with a spacing of plus or minus 2 micro-seconds, or more, from the nominal value and with any signal level up to the value specified in 3.5.4.2.3.3 shall be rejected such that the transmission rate does not exceed the value obtained when interrogations are absent.

3.5.4.3.4

DME/P - Decoder rejection. An interrogation pulse pair with a spacing of plus or minus 2 microseconds, or more, from the nominal value and with any signal level up to the value specified in 3.5.4.2.3.4 shall be rejected such that the transmission rate does not exceed the value obtained when interrogations are absent.

3.5.4.4 Time delay

3.5.4.4.1

When a DME is associated only with a VHF facility, the time delay shall be the interval from the half voltage point on the leading edge of the second constituent pulse of the interrogation pair and the half voltage point on the leading edge of the second constituent pulse of the reply transmission. This delay shall be consistent with the following table, when it is desired that aircraft interrogators are to indicate distance from the transponder site.

(See Annex for data)

3.5.4.4.2

When a DME is associated with an MLS angle facility, the time delay shall be the interval from the half voltage point on the leading edge of the first constituent pulse of the interrogation pair and the half voltage point on the leading edge of the first constituent pulse of the reply transmission. This delay shall be 50 microseconds for mode X channels and 56 microseconds for mode Y channels, when it is desired that aircraft interrogators are to indicate distance from the transponder site.

3.5.4.4.2.1

For DME/P transponders, no time delay adjustment shall be permitted.

3.5.4.4.3

For the DME/N the transponder time delay should be capable of being set to an appropriate value between the nominal value of the time delay minus 15 microseconds and the nominal value of the time delay, to permit aircraft interrogators to indicate zero distance at a specific point remote from the transponder site.

3.5.4.4.3.1

‡ DME/N. The time delay shall be the interval from the half voltage point on the leading edge of the first constituent pulse of the interrogation pair and the half voltage point on the leading edge of the first constituent pulse of the reply transmission.

3.5.4.4.3.2

DME/P - IA mode. The time delay shall be the interval from the half voltage point on the leading edge of the first constituent pulse of the interrogation pulse pair to the half voltage point on the leading edge of the first constituent pulse of the reply pulse pair.

3.5.4.4.3.3

DME/P - FA mode. The time delay shall be the interval from the virtual origin of the first constituent pulse of the interrogation pulse pair to the virtual origin of the first constituent pulse of the reply pulse pair. The time of arrival measurement points shall be within the partial rise time of the first constituent pulse of the pulse pair in each case.

3.5.4.4.4

DME/N. Transponders should be sited as near to the point at which zero indication is required as is practicable.

3.5.4.5 Accuracy

3.5.4.5.1

DME/N. The transponder shall not contribute more than plus or minus 1 microsecond (150 m (500 ft)) to the over-all system error.

3.5.4.5.2

‡ DME/N. A transponder associated with a landing aid shall not contribute more than plus or minus 0.5 microsecond (75 m (250 ft)) to the over-all system error.

3.5.4.5.3 DME/P - FA mode

3.5.4.5.3.1

Accuracy standard 1. The transponder shall not contribute more than plus or minus 10 m (plus or minus 33 ft) PFE and plus or minus 8 m (plus or minus 26 ft) CMN to the over-all system error.

3.5.4.5.3.2

Accuracy standard 2. The transponder shall not contribute more than plus or minus 5 m (plus or minus 16 ft) PFE and plus or minus 5 m (plus or minus 16 ft) CMN to the over-all system error.

3.5.4.5.4

DME/P - IA mode. The transponder shall not contribute more than plus or minus 15 m (plus or minus 50 ft) PFE and plus or minus 10 m (plus or minus 33 ft) CMN to the over-all system error.

3.5.4.5.5

When a DME is associated with an MLS angle facility, the above accuracy should include the error introduced by the first pulse detection due to the pulse spacing tolerances.

3.5.4.6 Efficiency

3.5.4.6.1

The transponder reply efficiency shall be at least 70 per cent for DME/N and DME/P (IA mode) and 80 per cent for DME/P (FA mode) at all values of transponder loading up to the loading corresponding to 3.5.3.5 above and at the minimum sensitivity level specified in 3.5.4.2.3.1 and 3.5.4.2.3.5 above.

3.5.4.6.2

Transponder dead time. The transponder shall be rendered inoperative for a period normally not to exceed 60 microseconds after a valid interrogation decode has occurred. In extreme cases when the geographical site of the transponder is such as to produce undesirable reflection problems, the dead time may be increased but only by the minimum amount necessary to allow the suppression of echoes for DME/N and DME/P IA mode.

3.5.4.6.2.1

In DME/P the IA mode dead time shall not blank the FA mode channel and vice versa.

3.5.4.7 Monitoring and control

3.5.4.7.1

Means shall be provided at each transponder site for the automatic monitoring and control of the transponder in use.

3.5.4.7.2 DME/N monitoring action

3.5.4.7.2.1

In the event that any of the conditions specified in 3.5.4.7.2.2 below occur, the monitor shall cause the following action to take place:

a) a suitable indication shall be given at a control point;

Difference:- Certain remotely sited DME do not provide an indication at a control point.

b) the operating transponder shall be automatically switched off; and

c) the standby transponder, if provided, shall be automatically placed in operation.

3.5.4.7.2.2

The monitor shall cause the actions specified in 3.5.4.7.2.1 above if:

a) the transponder delay differs from the assigned value by 1 microsecond (150 m (500 ft)) or more;

‡b) in the case of a DME/N associated with a landing aid, the transponder delay differs from the assigned value by 0.5 microsecond (75 m (250 ft)) or more.

3.5.4.7.2.3*

The monitor should cause the actions specified in 3.5.4.7.2.1 above if the spacing between the first and second pulse of the transponder pulse pair differs from the nominal value specified in the table following 3.5.4.4.1 above by 1 microsecond or more.

Difference:- Mandatory Standard

3.5.4.7.2.4

The monitor should also cause a suitable indication to be given at a control point if any of the following conditions arise:

a) a fall of 3 dB or more in transponder transmitted power output;

b) a fall of 6 dB or more in the minimum transponder receiver sensitivity (provided that this is not due to the action of the receiver automatic gain reduction circuits);

c) the spacing between the first and second pulse of the transponder reply pulse pair differs from the normal value specified in 3.5.4.1.4 above by 1 microsecond or more;

d) variation of the transponder receiver and transmitter frequencies beyond the control range of the reference circuits (if the operating frequencies are not directly crystal controlled).

3.5.4.7.2.5

Means shall be provided so that any of the conditions and malfunctioning enumerated in 3.5.4.7.2.2, 3.5.4.7.2.3 and 3.5.4.7.2.4 above which are monitored can persist for a certain period before the monitor takes action. This period shall be as low as practicable, but shall not exceed 10 seconds, consistent with the need for avoiding interruption, due to transient effects, of the service provided by the transponder.

3.5.4.7.2.6

The transponder shall not be triggered more than 120 times per second for either monitoring or automatic frequency control purposes, or both.

3.5.4.7.3 DME/P monitoring action

3.5.4.7.3.1

The monitor system shall cause the transponder radiation to cease and provide a warning at a control point if any of the following conditions persist for longer than the period specified:

a) there is a change in transponder PFE that exceeds the limits specified in either 3.5.4.5.3 or 3.5.4.5.4 above for more than one second. If the FA mode limit is exceeded, but the IA mode limit is maintained, the IA mode may remain operative;

b) there is a reduction in the effective radiated power to less than that necessary to satisfy the requirements specified in 3.5.4.1.5.3 above for a period of more than one second;

c) there is a reduction of 3 dB or more in the transponder sensitivity necessary to satisfy the requirements specified in 3.5.4.2.3 above for a period of more than five seconds in FA mode and ten seconds in IA mode (provided that this is not due to the action of the receiver automatic sensitivity reduction circuits);

d) the spacing between the first and second pulse of the transponder reply pulse pair differs from the value specified in the table in 3.5.4.4.1 above by 0.25 microsecond or more for a period of more than one second.

3.5.4.7.3.2

The monitor should cause a suitable indication to be given at a control point if there is an increase above 0.3 microseconds or a decrease below 0.2 microseconds of the reply pulse partial rise time which persists for more than one second.

3.5.4.7.3.3

The period during which erroneous guidance information is radiated shall not exceed the periods specified in 3.5.4.7.3.1 above. Attempts to clear a fault by resetting the primary ground equipment or by switching to standby ground equipment, if fitted, shall be completed within this time. If the fault is not cleared within the time allowed, the radiation shall cease. After shutdown, no attempt shall be made to restore service until a period of 20 seconds has elapsed.

3.5.4.7.3.4

The transponder shall not be triggered for monitoring purposes more than 120 times per second in the IA mode and 150 times per second in the FA mode.

3.5.4.7.3.5

DME/N and DME/P monitor failure. Failure of any part of the monitor itself shall automatically produce the same results as the malfunctioning of the element being monitored.

3.5.5 Technical characteristics of interrogator

3.5.5.1 Transmitter

3.5.5.1.1

Frequency of operation. The interrogator shall transmit on the interrogation frequency appropriate to the assigned DME channel (see 3.5.3.3.3 above).

3.5.5.1.2

Frequency stability. The radio frequency of operation shall not vary more than plus or minus 100 kHz from the assigned value.

3.5.5.1.3

Pulse shape and spectrum. The following shall apply to all radiated pulses:

a) Pulse rise time.

1) DME/N. Pulse rise time shall not exceed 3 microseconds.

2) DME/P. Pulse rise time shall not exceed 1.6 microseconds. For the FA mode, the pulse shall have a partial rise time of 0.25 plus or minus 0.05 microsecond. With respect to the FA mode and accuracy standard 1, the slope of the pulse in the partial rise time shall not vary by more than plus or minus 20 per cent. For accuracy standard 2 the slope shall not vary by more than plus or minus 10 per cent.

3) DME/P. Recommendation.- Pulse rise time should not exceed 1.2 microseconds.

b) Pulse duration shall be 3.5 microseconds plus or minus 0.5 microsecond.

c) Pulse decay time shall nominally be 2.5 microseconds, but shall not exceed 3.5 microseconds.

d) The instantaneous amplitude of the pulse shall not, at any instant between the point of the leading edge which is 95 per cent of maximum amplitude and the point of the trailing edge which is 95 per cent of the maximum amplitude, fall below a value which is 95 per cent of the maximum voltage amplitude of the pulse.

e) The spectrum of the pulse modulated signal shall be such that at least 90 per cent of the energy in each pulse shall be within 0.5 MHz in a band centred on the nominal channel frequency.

f) To ensure proper operation of the thresholding techniques, the instantaneous magnitude of any pulse turn-on transients which occur in time prior to the virtual origin shall be less than one per cent of the pulse peak amplitude. Initiation of the turn-on process shall not commence sooner than 1 microsecond prior to the virtual origin.

3.5.5.1.4 Pulse spacing

3.5.5.1.4.1

The spacing of the constituent pulses of transmitted pulse pairs shall be as given in the table in 3.5.4.4.1 above.

3.5.5.1.4.2

DME/N. The tolerance on the pulse spacing shall be plus or minus 0.5 microsecond.

3.5.5.1.4.3

DME/N. The tolerance on the pulse spacing should be plus or minus 0.25 micro-second.

3.5.5.1.4.4

DME/P. The tolerance on the pulse spacing shall be plus or minus 0.25 microsecond.

3.5.5.1.4.5

The pulse spacing shall be measured between the half voltage points on the leading edges of the pulses.

3.5.5.1.5 Pulse repetition frequency

3.5.5.1.5.1

The pulse repetition frequency shall be as specified in 3.5.3.4 above.

3.5.5.1.5.2

The variation in time between successive pairs of interrogation pulses shall be sufficient to prevent false lock-on.

3.5.5.1.5.3

DME/P. In order to achieve the system accuracy specified in 3.5.3.1.3.4 above, the variation in time between successive pairs of interrogation pulses shall be sufficiently random to decorrelate high frequency multipath errors.

3.5.5.1.6 Spurious radiation

During intervals between transmission of individual pulses, the spurious pulse power received and measured in a receiver having the same characteristics of a DME transponder receiver, but tuned to any DME interrogation or reply frequency, shall be more than 50 dB below the peak pulse power received and measured in the same receiver tuned to the interrogation frequency in use during the transmission of the required pulses. This provision shall apply to all spurious pulse transmissions. The spurious CW power radiated from the interrogator on any DME interrogation or reply frequency shall not exceed 20 microwatts (minus 47 dBW).

3.5.5.1.7

The spurious pulse power received and measured under the conditions stated in 3.5.5.1.6 above should be 80 dB below the required peak pulse power received.

3.5.5.1.8

DME/P. The peak effective radiated power (ERP) shall not be less than that required to ensure the power densities in 3.5.4.2.3.1 above under all operational weather conditions.

3.5.5.2 Time delay

3.5.5.2.1

The time delay shall be consistent with the table in 3.5.4.4.1 above.

3.5.5.2.2

DME/N. The time delay shall be the interval between the time of the half voltage point on the leading edge of the second constituent interrogation pulse and the time at which the distance circuits reach the condition corresponding to zero distance indication.

3.5.5.2.3

‡ DME/N. The time delay shall be the interval between the time of the half voltage point on the leading edge of the first constituent interrogation pulse and the time at which the distance circuits reach the condition corresponding to zero distance indication.

3.5.5.2.4

DME/P - IA mode. The time delay shall be the interval between the time of the half voltage point on the leading edge of the first constituent interrogation pulse and the time at which the distance circuits reach the condition corresponding to zero distance indication.

3.5.5.2.5

DME/P - FA mode. The time delay shall be the interval between the virtual origin of the leading edge of the first constituent interrogation pulse and the time at which the distance circuits reach the condition corresponding to zero distance indication. The time of arrival shall be measured within the partial rise time of the pulse.

3.5.5.3 Receiver

3.5.5.3.1

Frequency of operation. The receiver centre frequency shall be the transponder frequency appropriate to the assigned DME operating channel (see 3.5.3.3.3 above).

3.5.5.3.2 Receiver sensitivity

3.5.5.3.2.1

‡ DME/N. The airborne equipment sensitivity shall be sufficient to acquire and provide distance information to the accuracy specified in 3.5.5.4 below for the signal power density specified in 3.5.4.1.5.2 above.

3.5.5.3.2.2

DME/P. The airborne equipment sensitivity shall be sufficient to acquire and provide distance information to the accuracy specified in 3.5.5.4.2 and 3.5.5.4.3 below for the signal power densities specified in 3.5.4.1.5.3 above.

3.5.5.3.2.3

‡ DME/N. The performance of the interrogator shall be maintained when the power density of the transponder signal at the interrogator antenna is between the minimum values given in 3.5.4.1.5 above and a maximum of minus 18 dBW/m2.

3.5.5.3.2.4

DME/P. The performance of the interrogator shall be maintained when the power density of the transponder signal at the interrogator antenna is between the minimum values given in 3.5.4.1.5 and a maximum of minus 18 dBW/m2.

3.5.5.3 3 Bandwidth

3.5.5.3.3.1

DME/N. The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3, when the input signals are those specified in 3.5.4.1.3.

3.5.5.3.3.2

DME/P - IA mode. The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 when the input signals are those specified in 3.5.4.1.3. The 12-dB bandwidth shall not exceed 2 MHz and the 60-dB bandwidth shall not exceed 10 MHz.

3.5.5.3.3.3

DME/P - FA mode. The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 when the input signals are those specified in 3.5.5.1.3. The 12-dB bandwidth shall not exceed 6 MHz and the 60-dB bandwidth shall not exceed 20 MHz.

3.5.5.3.4 Interference rejection

3.5.5.3.4.1

When there is a ratio of desired to undesired co-channel DME signals of at least 8 dB at the input terminals of the airborne receiver, the interrogator shall display distance information and provide unambiguous identification from the stronger signal.

3.5.5.3.4.2

‡ DME/N. DME signals greater than 900 kHz removed from the desired channel nominal frequency and having amplitudes up to 42 dB above the threshold sensitivity shall be rejected.

3.5.5.3.4.3

DME/P. DME signals greater than 900 kHz removed from the desired channel nominal frequency and having amplitudes up to 42 dB above the threshold sensitivity shall be rejected.

3.5.5.3.5 Decoding

3.5.5.3.5.1

The interrogator shall include a decoding circuit such that the receiver can be triggered only by pairs of received pulses having pulse duration and pulse spacings appropriate to transponder signals as described in 3.5.4.1.4.

3.5.5.3.5.2

‡ DME/N - Decoder rejection. A reply pulse pair with a spacing of plus or minus 2 microseconds, or more, from the nominal value and with any signal level up to 42 dB above the receiver sensitivity shall be rejected.

3.5.5.3.5.3

DME/P - Decoder rejection. A reply pulse pair with a spacing of plus or minus 2 microseconds, or more, from the nominal value and with any signal level up to 42 dB above the receiver sensitivity shall be rejected.

3.5.5.4 Accuracy

3.5.5.4.1

‡ DME/N. The interrogator shall not contribute more than plus or minus 315 m (plus or minus 0.17 NM) to the over-all system error.

3.5.5.4.2

DME/P - IA mode. The interrogator shall not contribute more than plus or minus 30 m (plus or minus 100 ft) to the over-all system PFE and not more than plus or minus 15 m (plus or minus 50 ft) to the over-all system CMN.

3.5.5.4.3 DME/P - FA mode

3.5.5.4.3.1

Accuracy standard 1. The interrogator shall not contribute more than plus or minus 15 m (plus or minus 50 ft) to the over-all system PFE and not more than plus or minus 10 m (plus or minus 33 ft) to the over-all system CMN.

3.5.5.4.3.2

Accuracy standard 2. The interrogator shall not contribute more than plus or minus 7 m (plus or minus 23 ft) to the over-all system PFE and not more than plus or minus 7 m (plus or minus 23 ft) to the overall system CMN.

3.5.5.4.4

DME/P. The interrogator shall achieve the accuracy specified in 3.5.3.1.3.4 with a system efficiency of 50 per cent or more.

3.6 Specification for en-route VHF marker beacons (75 MHz)

3.6.1 Equipment

3.6.1.1 Frequencies

The emissions of an en-route VHF marker beacon shall have a radio frequency of 75 MHz plus or minus 0.005 per cent.

3.6.1.2 Characteristics of emissions

3.6.1.2.1

Radio marker beacons shall radiate an uninterrupted carrier modulated to a depth of not less than 95 per cent or more than 100 per cent. The total harmonic content of the modulation shall not exceed 15 per cent.

3.6.1.2.2

The frequency of the modulating tone shall be 3 000 Hz plus or minus 75 Hz.

3.6.1.2.3

The radiation shall be horizontally polarized.

3.6.1.2.4 Identification

If a coded identification is required at a radio marker beacon, the modulating tone shall be keyed so as to transmit dots or dashes or both in an appropriate sequence. The mode of keying shall be such as to provide a dot-and-dash duration together with spacing intervals corresponding to transmission at a rate equivalent to approximately six to ten words per minute. The carrier shall not be interrupted during identification.

3.6.1.2.5 Coverage and radiation pattern

Note

3.6.1.2.6 Determination of coverage

The limits of coverage of marker beacons shall be determined on the basis of the field strength specified in 3.1.7.3.2.

3.6.1.2.7 Radiation pattern

The radiation pattern of a marker beacon normally should be such that the polar axis is vertical, and the field strength in the pattern is symmetrical about the polar axis in the plane or planes containing the flight paths for which the marker beacon is intended.

3.6.1.3 Monitoring

For each marker beacon, suitable monitoring equipment should be provided which will show at an appropriate location:

a) a decrease in radiated carrier power below 50 per cent of normal;

b) a decrease of modulation depth below 70 per cent;

c) a failure of keying.

3.7 Requirements for the Global Navigation Satellite System (GNSS)

3.7.1 Definitions

Aircraft-based augmentation system (ABAS). An augmentation system that augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft.

Alert. An indication provided to other aircraft systems or annunciation to the pilot to identify that an operating parameter of a navigation system is out of tolerance.

Alert limit. For a given parameter measurement, the error tolerance not to be exceeded without issuing an alert.

Channel of standard accuracy (CSA). The specified level of positioning, velocity and timing accuracy that is available to any GLONASS user on a continuous, worldwide basis.

Core satellite constellation(s). The core satellite constellations are GPS and GLONASS.

Global navigation satellite system (GNSS). A worldwide position and time determination system that includes one or more satellite constellations, aircraft receivers and system integrity monitoring, augmented as necessary to support the required navigation performance for the intended operation.

Global navigation satellite system (GLONASS). The satellite navigation system operated by the Russian Federation.

Global positioning system (GPS). The satellite navigation system operated by the United States.

GNSS position error. The difference between the true position and the position determined by the GNSS receiver.

Ground-based augmentation system (GBAS). An augmentation system in which the user receives augmentation information directly from a ground-based transmitter.

Ground-based regional augmentation system (GRAS). An augmentation system in which the user receives augmentation information directly from one of a group of a ground-based transmitters covering a region.

Integrity. A measure of the trust that can be placed in the correctness of the information supplied by the total system. Integrity includes the ability of a system to provide timely and valid warnings to the user (alerts).

Pseudo-range. The difference between the time of trans-mission by a satellite and reception by a GNSS receiver multiplied by the speed of light in a vacuum, including bias due to the difference between a GNSS receiver and satellite time reference.

Satellite-based augmentation system (SBAS). A wide coverage augmentation system in which the user receives augmentation information from a satellite-based transmitter.

Standard positioning service (SPS). The specified level of positioning, velocity and timing accuracy that is available to any global positioning system (GPS) user on a continuous, worldwide basis.

Time-to-alert. The maximum allowable time elapsed from the onset of the navigation system being out of tolerance until the equipment enunciates the alert.

3.7.2 General

3.7.2.1 Functions

3.7.2.1.1

The GNSS shall provide position and time data to the aircraft.

3.7.2.2 GNSS elements

3.7.2.2.1

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

a) Global Positioning System (GPS) that provides the Standard Positioning Service (SPS) as defined in 3.7.3.1;

b) Global Navigation Satellite System (GLONASS) that provides the Channel of Standard Accuracy (CSA) navigation signal as defined in 3.7.3.2;

c) aircraft-based augmentation system (ABAS) as defined in 3.7.3.3;

d) satellite-based augmentation system (SBAS) as defined in 3.7.3.4;

e) ground-based augmentation system (GBAS) as defined in 3.7.3.5; and

f) ground-based regional augmentation system (GRAS) as defined in 3.7.3.5 and

f) aircraft GNSS receiver as defined in 3.7.3.6.

3.7.2.3 Space and time reference

3.7.2.3.1 Space reference

The position information provided by the GNSS to the user shall be expressed in terms of the World Geodetic System - 1984 (WGS-84) geodetic reference datum.

3.7.2.3.2 Time reference

The time data provided by the GNSS to the user shall be expressed in a time scale that takes the Universal Time Coordinated (UTC) as reference.

3.7.2.4 Signal-in-space performance

3.7.2.4.1

The combination of GNSS elements and a fault-free GNSS user receiver shall meet the signal-in-space requirements defined in Table 3.7.2.4-1 (located at the end of section 3.7).

3.7.3 GNSS elements specifications

3.7.3.1 GPS Standard Positioning Service (SPS) (L1)

3.7.3.1.1

Space and control segment accuracy

3.7.3.1.1.1 Positioning accuracy

The GPS SPS position errors shall not exceed the following limits:

(See Annex for data)

3.7.3.1.1.2 Time transfer accuracy

The GPS SPS time transfer errors shall not exceed 40 nanoseconds 95 per cent of the time.

3.7.3.1.1.3 Range domain accuracy

The range domain error shall not exceed the following limits:

a) range error of any satellite - the larger of:

- 30 metres (100 ft); or
- 4.42 times the broadcast user range accuracy (URA),

not to exceed 150 metres (490 ft);

b) range rate error of any satellite - 0.02 metres (0.07 ft) per second;

c) range acceleration error of any satellite - 0.007 metres (0.02 ft) per second-squared; and

d) root-mean-square range error over all satellites - 6 metres (20 ft).

3.7.3.1.2 Availability.

The GPS SPS availability shall be as follows:

(See Annex for data)

3.7.3.1.3 Reliability

The GPS SPS reliability shall be within the following limits:

a) frequency of a major service failure - not more than three per year for the constellation (global average);

b) reliability - at least 99.94 per cent (global average); and

c) reliability - at least 99.79 per cent (single pont average).

3.7.3.1.4 Coverage

The GPS SPS shall cover the surface of the earth up to an altitude of 3 000 kilometres.

3.7.3.1.5 Radio frequency (RF) characteristics

3.7.3.1.5.1 Carrier frequency

Each GPS satellite shall broadcast an SPS signal at the carrier frequency of 1 575.42 MHz (GPS L1) using code division multiple access (CDMA).

3.7.3.1.5.2 Signal spectrum

The GPS SPS signal power shall be contained within a ±12 MHz band (1 563.42 -1 587.42 MHz) centred on the L1 frequency.

3.7.3.1.5.3 Polarization

The transmitted RF signal shall be right-hand (clockwise) circularly polarized.

3.7.3.1.5.4 Signal power level

Each GPS satellite shall broadcast SPS navigation signals with sufficient power such that, at all unobstructed locations near the ground from which the satellite is observed at an elevation angle of 5 degrees or higher, the level of the received RF signal at the output of a 3 dBi linearly-polarized antenna is within the range of -160 dBW to -153 dBW for all antenna orientations orthogonal to the direction of propagation.

3.7.3.1.5.5 Modulation

The SPS L1 signal shall be bipolar phase shift key (BPSK) modulated with a pseudo random noise (PRN) 1.023 MHz coarse/acquisition (C/A) code. The C/A code sequence shall be repeated each millisecond. The transmitted PRN code sequence shall be the Modulo-2 addition of a 50 bits per second navigation message and the C/A code.

3.7.3.1.6 GPS time

GPS time shall be referenced to UTC (as maintained by the U.S. Naval Observatory).

3.7.3.1.7 Coordinate system

The GPS coordinate system shall be WGS-84.

3.7.3.1.8 Navigation information

The navigation data transmitted by the satellites shall include the necessary information to determine:

a) satellite time of transmission;

b) satellite position;

c) satellite health;

d) satellite clock correction;

e) propagation delay effects;

f) time transfer to UTC; and

g) constellation status.

3.7.3.2 GLONASS Channel of Standard Accuracy (CSA) (L1)

3.7.3.2 1 Accuracy

3.7.3.2.1.1 Positioning accuracy

The GLONASS CSA position errors shall not exceed the following limits:

(See Annex for data)

3.7.3.2.1.2 Time transfer accuracy.

The GLONASS CSA time transfer errors shall not exceed 700 nanoseconds 95 per cent of the time.

3.7.3.2.2 Availability

The GLONASS CSA availability shall be at least 99.64 per cent (global average).

3.7.3.2.3 Reliability

The GLONASS CSA reliability shall be at least 99.98 per cent (global average).

3.7.3.2.4 Coverage

The GLONASS CSA coverage shall be at least 99.9 per cent (global average).

3.7.3.2.5 RF characteristics

3.7.3.2.5.1 Carrier frequency

Each GLONASS satellite shall broadcast CSA navigation signal at its own carrier frequency in the L1 (1.6 GHz) frequency band using frequency division multiple access (FDMA).

3.7.3.2.5.2 Signal spectrum

GLONASS CSA signal power shall be contained within a ±5.75 MHz band centred on each GLONASS carrier frequency.

3.7.3.2.5.3 Polarization

The transmitted RF signal shall be right-hand circularly polarized.

3.7.3.2.5.4 Signal power level

Each GLONASS satellite shall broadcast CSA navigation signals with sufficient power such that, at all unobstructed locations near the ground from which the satellite is observed at an elevation angle of 5 degrees or higher, the level of the received RF signal at the output of a 3dBi linearly polarized antenna is within the range of -161 dBW to -155.2 dBW for all antenna orientations orthogonal to the direction of propagation.

3.7.3.2.5.5 Modulation

3.7.3.2.5.5.1

Each GLONASS satellite shall transmit at its carrier frequency the navigation RF signal using a BPSK- modulated binary train. The phase shift keying of the carrier shall be performed at -radians with the maximum error ±0.2 radian. The pseudo-random code sequence shall be repeated each millisecond.

3.7.3.2.5.5.2

The modulating navigation signal shall be generated by the Modulo-2 addition of the following three binary signals:

a) ranging code transmitted at 511 kbits/s;

b) navigation message transmitted at 50 bits/s; and

c) 100 Hz auxiliary meander sequence.

3.7.3.2.6 GLONASS time

GLONASS time shall be referenced to UTC(SU) (as maintained by the National Time Service of Russia).

3.7.3.2.7 Coordinate system

The GLONASS coordinate system shall be PZ-90.

3.7.3.2.8 Navigation information

The navigation data transmitted by the satellite shall include the necessary information to determine:

a) satellite time of transmission;

b) satellite position;

c) satellite health;

d) satellite clock correction;

e) time transfer to UTC; and

f) constellation status.

3.7.3.3 Aircraft-based augmentation system (ABAS)

3.7.3.3.1 Performance

The ABAS function combined with one or more of the other GNSS elements and both a fault-free GNSS receiver and fault-free aircraft system used for the ABAS function shall meet the requirements for accuracy, integrity, continuity and availability as stated in 3.7.2.4.

3.7.3.4 Satellite-based augmentation system (SBAS)

3.7.3.4.1 Performance

SBAS combined with one or more of the other GNSS elements and a fault-free receiver shall meet the requirements for system accuracy, integrity, continuity and availability for the intended operation as stated in 3.7.2.4.

3.7.3.4.2 Functions

SBAS shall perform one or more of the following functions:

a) ranging: provide an additional pseudo-range signal with an accuracy indicator from a SBAS satellite (3.7.3.4.2.1 and Appendix B, 3.5.7.2);

b) GNSS satellite status: determine and transmit the GNSS satellite health status (Appendix B, 3.5.7.3);

c) basic differential correction: provide GNSS satellite ephemeris and clock corrections (fast and long-term) to be applied to the pseudo-range measurements from satellites (Appendix B, 3.5.7.4); and

d) precise differential correction: determine and transmit the ionospheric corrections (Appendix B, 3.5.7.5).

3.7.3.4.2.1 Ranging

3.7.3.4.2.1.1

Excluding atmospheric effects, the range error for the ranging signal from SBAS satellites shall not exceed 25 metres (95 per cent).

3.7.3.4.2.1.2

The probability that the range error exceeds 150 metres in any hour shall not exceed 10-5.

3.7.3.4.2.1.3

The probability of unscheduled outages of the ranging function from an SBAS satellite in any hour shall not exceed 10-3.

3.7.3.4.2.1.4

The range rate error shall not exceed 2 metres per second.

3.7.3.4.2.1.5

The range acceleration error shall not exceed 0.019 metres per second-squared.

3.7.3.4.3 Service area

The SBAS service area shall be a defined area within an SBAS coverage area where SBAS meets the requirements of 3.7.2.4 and supports the corresponding approved operations.

3.7.3.4.4 RF characteristics

3.7.3.4.4.1 Carrier frequency

The carrier frequency shall be 1 575.42 MHz.

3.7.3.4.4.2 Signal spectrum

At least 95 per cent of the broadcast power shall be contained within a ±12 MHz band centred on the L1 frequency. The bandwidth of the signal transmitted by an SBAS satellite shall be at least 2.2 MHz.

3.7.3.4.4.3 Signal power level

Each SBAS satellite shall broadcast navigation signals with sufficient power such that, at all unobstructed locations near the ground from which the satellite is observed at an elevation angle of 5 degrees or higher, the level of the received RF signal at the output of a 3 dBi linearly polarized antenna is within the range of -161 dBW to -153 dBW for all antenna orientations orthogonal to the direction of propagation.

3.7.3.4.4.4 Polarization

The broadcast signal shall be right-hand circularly polarized.

3.7.3.4.4.5 Modulation

The transmitted sequence shall be the Modulo-2 addition of the navigation message at a rate of 500 symbols per second and the 1 023 bit pseudo-random noise code. It shall then be BPSK-modulated onto the carrier at a rate of 1.023 megachips per second.

3.7.3.4.5 SBAS network time (SNT)

The difference between SNT and GPS time shall not exceed 50 nanoseconds.

3.7.3.4.6 Navigation information

The navigation data transmitted by the satellites shall include the necessary information to determine:

a) SBAS satellite time of transmission;

b) SBAS satellite position;

c) corrected satellite time for all satellites;

d) corrected satellite position for all satellites;

e) ionospheric propagation delay effects;

f) user position integrity;

g) time transfer to UTC; and

h) service level status.

3.7.3.5 Ground-based augmentation system (GBAS) and ground-based regional augmentation system (GRAS)

3.7.3.5.1 Performance

GBAS combined with one or more of the other GNSS elements and a fault-free GNSS receiver shall meet the requirements for system accuracy, continuity, availability and integrity for the intended operation as stated in 3.7.2.4.

3.7.3.5.2 Functions

GBAS shall perform the following functions:

a) provide locally relevant pseudo-range corrections;

b) provide GBAS-related data;

c) provide final approach segment data when supporting precision approach;

d) provide predicted ranging source availability data; and

e) provide integrity monitoring for GNSS ranging sources.

3.7.3.5.3 Coverage

3.7.3.5.3.1

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

a) 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

b) 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.

3.7.3.5.3.1.1*

For Category I precision approach the data broadcast as specified in 3.7.3.5.4 should extend down to 3.7 m (12 ft) above the runway surface.

3.7.3.5.3.1.2*

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

3.7.3.5.3.2

GBAS positioning service. The GBAS positioning service area shall be that area where the data broadcast can be received and the positioning service meets the requirements of 3.7.2.4 and supports the corresponding approved operations.

3.7.3.5.4 Data broadcast characteristics

3.7.3.5.4.1 Carrier frequency

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

3.7.3.5.4.2 Access technique

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

3.7.3.5.4.3 Modulation

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

3.7.3.5.4.4 Data broadcast RF field strength and polarization

3.7.3.5.4.4.1.1 GBAS/H.

A horizontally polarized signal shall be broadcast.

3.7.3.5.4.4.1.2

The effective radiated power (ERP) shall provide for a horizontally polarized signal with a minimum field strength of 215 microvolts per metre (-99 dBW/metres-squared) and a maximum field strength of 0.350 volts per metre (-35 dBW/metres-squared) within the GBAS coverage volume. The field strength shall 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 shall be such that the minimum signal power defined in Appendix B, 3.6.8.2.2.3 is achieved for HPOL users throughout the coverage volume.

3.7.3.5.4.4.2 GBAS/E

3.7.3.5.4.4.2.1

An elliptically polarized signal should be broadcast whenever practical.

3.7.3.5.4.4.2.2

When an elliptically polarized signal is broadcast, the horizontally polarized component shall meet the requirements in 3.7.3.5.4.4.1.2, and the effective radiated power (ERP) shall provide for a vertically polarized signal with a minimum field strength of 136 microvolts per metre (-103 dBW/m2) and a maximum field strength of 0.221 volts per metre (-39 dBW/m2) within the GBAS coverage volume. The field strength shall 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, shall be such that the minimum signal power defined in Appendix B, 3.6.8.2.2.3 is achieved for HPOL and VPOL users throughout the coverage volume.

3.7.3.5.4.5 Power transmitted in adjacent channels

The amount of power during transmission under all operating conditions when measured over a 25 kHz bandwidth centred on the ith adjacent channel shall not exceed the values shown in Table 3.7.3.5-1 (located at the end of section 3.7).

3.7.3.5.4.6 Unwanted emissions

Unwanted emissions, including spurious and out-of-band emissions, shall be compliant with the levels shown in Table 3.7.3.5-2 (located at the end of section 3.7). The total power in any VDB harmonic or discrete signal shall not be greater than -53 dBm.

3.7.3.5.5 Navigation information

The navigation data transmitted by GBAS shall include the following information:

a) pseudo-range corrections, reference time and integrity data;

b) GBAS-related data;

c) final approach segment data when supporting precision approach; and

d) predicted ranging source availability data.

3.7.3.6 Aircraft GNSS receiver

3.7.3.6.1

The aircraft GNSS receiver shall process the signals of those GNSS elements that it intends to use as specified in Appendix B, 3.1 (for GPS), Appendix B, 3.2 (for GLONASS), Appendix B, 3.3 (for combined GPS and GLONASS), Appendix B, 3.5 (for SBAS) and Appendix B, 3.6 (for GBAS and GRAS).

3.7.4 Resistance to interference

3.7.4.1

GNSS shall comply with performance requirements defined in 3.7.2.4 and Appendix B, 3.7 in the presence of the interference environment defined in Appendix B, 3.7.

3.7.5 Database

3.7.5.1

Aircraft GNSS equipment that uses a database shall provide a means to:

a) update the electronic navigation database; and

b) determine the Aeronautical Information Regulation and Control (AIRAC) effective dates of the aeronautical database.

Compliance Statement

Alternative means of compliance:

In accordance with Civil Aviation Rule 19.207 (Primary means GPS operations) each person operating an aircraft under IFR using GPS equipment as a primary means navigation system shall, amongst other things, if intending to use a GPS based instrument approach procedure, obtain a RAIM prediction prior to departure for the expected time of arrival at the destination—

(i) using the onboard GPS receiver; or

(ii) from the holder of an air traffic service organisation certificate issued under Part 172; and

And ensure that en-route and terminal navigation is conducted—

(i) using a GPS database containing data that is current with respect to the current en-route and area charts applicable to the route being flown; and

(ii) by cross checking each GPS database selected track and distance between reporting points, for accuracy and reasonableness by reference to current en-route and area charts.

And ensure all GPS instrument approaches are accomplished in accordance with approved instrument approach procedures using a GPS database containing data that is current with respect to the current published Instrument Approach Chart for the approach procedure being flown.

In accordance with Civil Aviation Rule 19.209 (Sole means GPS operations)

(a) A person shall not operate an aircraft under IFR using a sole means navigation system, which uses only GPS sensors, within the New Zealand Flight Information Region.

(b) Each person operating a New Zealand registered aircraft under IFR using a sole means navigation system which uses only GPS sensors, in the Auckland Oceanic Flight Information Region, shall—

(1) ensure that—

(i) the GPS equipment is approved to Level 1 on form CAA 2129; and

(ii) the aircraft's form CAA 2129 has been endorsed, approving the GPS equipment for use on the intended IFR operation as a sole means navigation system; and

(2) operate the GPS equipment in accordance with the aircraft flight manual or aircraft flight manual supplement; and

(3) ensure that en-route navigation is conducted—

(i) using a GPS database containing data that is current with respect to the current published en-route and area charts applicable to the route being flown; and

(ii) by cross checking each GPS database selected track and distance between reporting points used for accuracy and reasonableness by reference to current en-route charts; and

(4) if a RAIM warning has been displayed for more than ten minutes, or the GPS equipment has operated in the DR mode for more than one minute advise the appropriate controlling ATC service.

3.7.6 Status monitoring and NOTAM

3.7.6.1

Changes in the current and projected status of GNSS space and ground elements that may have an impact on user performance or operational approvals shall be reported to relevant air traffic service units.

Compliance Statement

New Zealand uses the Australian RAIM Prediction Service.

Aeronautical Information Circular (AIC) H20/98, dated 16 July 1998, provides details of the Australian GPS Receiver Autonomous Integrity Monitoring (RAIM) Prediction Service. This service is an enhancement to the pre-flight briefing services provided for those aerodromes with a GPS non-precision approach. New Zealand, Tonga, Canada and East Timor now also use the Australian RAIM Prediction Service.

3.8 Reserved

3.9 System characteristics of airborne ADF receiving systems

3.9.1 Accuracy of bearing indication

3.9.1.1

The bearing given by the ADF system shall not be in error by more than plus or minus 5 degrees with a radio signal from any direction having a field strength of 70 microvolts per metre or more radiated from an LF/MF NDB or locator operating within the tolerances permitted by this Annex and in the presence also of an unwanted signal from a direction 90 degrees from the wanted signal and:

a) on the same frequency and 15 dB weaker; or

b) plus or minus 2 kHz away and 4 dB weaker; or

c) plus or minus 6 kHz or more away and 55 dB stronger.

Compliance Statement

New Civil Aviation Rules (Part 91) require compliance with TSO C41 AIRBORNE AUTOMATIC DIRECTION FINDING (ADF) EQUIPMENT

3.10 Reserved

3.11 Microwave landing system (MLS) characteristics

3.11.1 Definitions

Auxiliary data. Data, transmitted in addition to basic data, that provide ground equipment siting information for use in refining airborne position calculations and other supplementary information.

Basic data. Data transmitted by the ground equipment that are associated directly with the operation of the landing guidance system.

Beam centre. The midpoint between the two minus 3-dB points on the leading and trailing edges of the scanning beam main lobe.

Beamwidth. The width of the scanning beam main lobe measured at the minus 3-dB points and defined in angular units on the boresight, in the horizontal plane for the azimuth function and in the vertical plane for the elevation function.

Clearance guidance sector. The volume of airspace, inside the coverage sector, within which the azimuth guidance information provided is not proportional to the angular displacement of the aircraft, but is a constant left or right indication of which side the aircraft is with respect to the proportional guidance sector.

Control motion noise (CMN). That portion of the guidance signal error which causes control surface, wheel and column motion and could affect aircraft attitude angle during coupled flight, but does not cause aircraft displacement from the desired course and/or glide path. (See 3.5.)

Coordinate system - conical. A function is said to use conical coordinates when the decoded guidance angle varies as the minimum angle between the surface of a cone containing the receiver antenna, and a plane perpendicular to the axis of the cone and passing through its apex. The apex of the cone is at the antenna phase centre. For approach azimuth or back azimuth functions, the plane is the vertical plane containing the runway centre line. For elevation functions, the plane is horizontal.

Coordinate system - planar. A function is said to use planar coordinates when the decoded guidance angle varies as the angle between the plane containing the receiver antenna and a reference plane. For azimuth functions, the reference plane is the vertical plane containing the runway centre line and the plane containing the receiver antenna is a vertical plane passing through the antenna phase centre.

Coverage sector. A volume of airspace within which service is provided by a particular function and in which the signal power density is equal to or greater than the specified minimum.

DME/P. The distance measuring element of the MLS, where the “P” stands for precise distance measurement. The spectrum characteristics are those of DME/N.

Function. A particular service provided by the MLS, e.g. approach azimuth guidance, back azimuth guidance or basic data, etc.

Mean course error. The mean value of the azimuth error along the runway extended centre line.

Mean glide path error. The mean value of the elevation error along the glide path of an elevation function.

Minimum glide path. The lowest angle of descent along the zero degree azimuth that is consistent with published approach procedures and obstacle clearance criteria.

MLS antenna boresight. The plane passing through the antenna phase centre perpendicular to the horizontal axis contained in the plane of the antenna array.

MLS azimuth. The locus of points in any horizontal plane where the decoded guidance angle is constant.

MLS approach reference datum. A point at a specified height above the intersection of the runway centre line and the threshold.

MLS back azimuth reference datum. A point at a specified height above the runway centre line at the runway midpoint.

MLS datum point. The point on the runway centre line closest to the phase centre of the approach elevation antenna.

MLS elevation. The locus of points in any vertical plane where the decoded guidance angle is constant.

MLS zero degree azimuth. The MLS azimuth where the decoded guidance angle is zero degrees.

Out-of-coverage indication signal. A signal radiated into areas outside the intended coverage sector where required to specifically prevent invalid removal of an airborne warning indication in the presence of misleading guidance information.

Path following error (PFE). That portion of the guidance signal error which could cause aircraft displacement from the desired course and/or glide path.

Path following noise (PFN). That portion of the guidance signal error which could cause aircraft displacement from the mean course line or mean glide path as appropriate.

Proportional guidance sector. The volume of airspace within which the angular guidance information provided by a function is directly proportional to the angular displacement of the airborne antenna with respect to the zero angle reference.

3.11.2 General

3.11.2.1

MLS is a precision approach and landing guidance system which provides position information and various ground to air data. The position information is provided in a wide coverage sector and is determined by an azimuth angle measurement, an elevation angle measurement and a range (distance) measurement.

3.11.3 MLS configurations

3.11.3.1 Basic MLS

The basic configuration of the MLS shall be composed of the following:

a) approach azimuth equipment, associated monitor, remote control and indicator equipment;

b) approach elevation equipment, associated monitor, remote control and indicator equipment;

c) a means for the encoding and transmission of essential data words, associated monitor, remote control and indicator equipment;

d) DME/N, associated monitor, remote control and indicator equipment.

3.11.3.2

If precise ranging information throughout the azimuth coverage sector is required, the option of DME/P, conforming to the Standards of Chapter 3, 3.5 should be applied.

3.11.3.3 Expanded MLS configurations

It shall be permissible to derive expanded configurations from the basic MLS, by addition of one or more of the following functions or characteristic improvements:

a) back azimuth equipment, associated monitor, remote control and indicator equipment;

b) flare elevation equipment, associated monitor, remote control and indicator equipment;

c) DME/P, associated monitor, remote control and indicator equipment;

d) a means for the encoding and transmission of additional auxiliary data words, associated monitor, remote control and indicator equipment;

e) a wider proportional guidance sector exceeding the minimum specified in 3.11.5 below.

3.11.3.4 Simplified MLS configurations

It shall be permissible to derive simplified configurations from the basic MLS (3.11.3.1), by relaxation of characteristics as follows:

a) an approach azimuth coverage provided in approach region (3.11.5.2.2.1.1) only;

b) an approach azimuth and elevation coverage (3.11.5.2.2 and 3.11.5.3.2) not extending below a height of 30 m (100 ft) above the threshold;

c) accuracy limits for PFE and PFN expanded to be not greater than 1.5 times the values specified in 3.11.4.9.4 for approach azimuth guidance and in 3.11.4.9.6 for elevation guidance;

d) ground equipment contribution to the mean course error and to the mean glide path error expanded to be 1.5 times the values specified in 3.11.5.2.4 and 3.11.5.3.4, respectively;

e) CMN requirements (3.11.4.9.4 and 3.11.4.9.6) waived; and

f) monitor and control action period (3.11.5.2.3 and 3.11.5.3.3) expanded to a six-second period.

3.11.4 Signal-in-space characteristics - angle and data functions

3.11.4.1 Channelling

3.11.4.1.1 Channel arrangement

The MLS angle and data functions shall operate on any one of the 200 channels assigned on the frequencies from 5 031.0 MHz to 5 090.7 MHz as shown in Table A.

3.11.4.1.1.1

Channel assignments in addition to those specified in 3.11.4.1.1 shall be made within the 5 030.4 to 5 150.0 MHz sub-band as necessary to satisfy future air navigation requirements.

3.11.4.1.2 Channel pairing with DME

The channel pairing of the angle and data channel with the channel of the ranging function shall be taken in accordance with Table A.

3.11.4.1.3 Frequency tolerance

The operating radio frequency of the ground equipment shall not vary more than plus or minus 10 kHz from the assigned frequency. The frequency stability shall be such that there is no more than a plus or minus 50 Hz deviation from the nominal frequency when measured over a one-second interval.

3.11.4.1.4 Radio frequency signal spectrum

3.11.4.1.4.1

The transmitted signal shall be such that, during the transmission time, the mean power density above a height of 600 m (2 000ft) shall not exceed -94.5 dBW/m2 for angle guidance or data signals, as measured in a 150 kHz bandwidth centred 840 kHz or more from the nominal frequency.

3.11.4.1.4.2

The transmitted signal shall be such that, during the transmission time, the mean power density beyond a distance of 4 800 m (2.6 NM)from any antenna and for a height below 600 m (2000 ft) shall not exceed -94.5 dBW/m2 for angle guidance or data signals, as measured in a 150 kHz bandwidth centred 840 kHz or more from the nominal frequency.

3.11.4.2 Polarization

The radio frequency transmissions from all ground equipment shall be nominally vertically polarized. The effect of any horizontally polarized component shall not cause the guidance information to change by more than 40 per cent of the PFE allowed at that location with the airborne antenna rotated 30 degrees from the vertical position or cause the PFE limit to be exceeded.

3.11.4.3 Time-division-multiplex (TDM) organization

3.11.4.3.1

Both angle information and data shall be transmitted by TDM on a single radio frequency channel.

3.11.4.3.2 Synchronization

The transmissions from the various angle and data ground equipments serving a particular runway shall be time synchronized to assure interference-free operations on the common radio frequency channel of operation.

3.11.4.3.3 Function rates

Each function transmitted shall be repeated at the rates shown in the following table:

Function	Average rate (Hz) measured over any 10-second period
Approach azimuth guidance	13 ± 0.5
High rate approach azimuth guidance	39 ± 1.5
Back azimuth guidance	6.5 ± 0.25
Approach elevation guidance	39 ± 1.5
Flare elevation guidance	39 ± 1.5
Basic data	see Appendix A, Table A-7
Auxiliary data	see Appendix A, Tables A-10 and A-12

3.11.4.3.3.1

When the proportional guidance sector is not greater than plus or minus 40 degrees and a need for flare elevation or other growth functions at that facility is not anticipated, the high rate approach azimuth function should be used.

3.11.4.3.4 Function timing

Timing standards for each angle and data function shall be as specified in Appendix A, Tables A-1 through A-6 and A-8. The ground equipment internal timing accuracy of each listed event including jitter shall be the specified nominal value plus or minus 2 microseconds. The timing jitter shall be less than 1 microsecond root mean square (RMS).

3.11.4.3.5 Function sequence

The time interval between repetitive transmissions of any one function shall be varied in a manner which provides protection from synchronous interference.

3.11.4.4 Preamble

3.11.4.4.1

A preamble signal shall be transmitted throughout the applicable coverage sector to identify the particular function to follow. The preamble shall consist of a radio frequency carrier acquisition period, a receiver reference time code, and a function identification code. The timing of the preamble transmissions shall be as specified in Appendix A, Table A-1.

3.11.4.4.2 Carrier acquisition

The preamble trans-mission shall begin with a period of unmodulated radio frequency carrier as specified in Appendix A, Table A-1.

3.11.4.4.3 Modulation and coding

3.11.4.4.3.1 Differential phase shift keying (DPSK)

The preamble codes and the basic and auxiliary data signals specified in 3.11.4.8 below shall be transmitted by DPSK of the radio frequency carrier. A “zero” shall be represented by a 0 degrees plus or minus 10 degrees phase shift and a “one” shall be represented by a 180 degrees plus or minus 10 degrees phase shift. The modulation rate shall be 15 625 bauds. The internal timing accuracy of the DPSK transition shall be as specified in 3.11.4.3.4 above. There shall be no amplitude modulation applied during the phase transition. The transition time shall not exceed 10 microseconds, and the phase shall advance or retard monotonically throughout the transition region.

3.11.4.4.3.2 Receiver reference time

All preambles shall contain the receiver reference time code, 11101 (bits I1 to I5). The time of the last phase transition midpoint in the code shall be the receiver reference time. The receiver reference time code shall be validated by decoding a valid function identification immediately following the receiver reference time code.

3.11.4.4.3.3 Function identification

A code for function identification shall follow the receiver reference time code. This code shall consist of the five information bits (I6 to I10) allowing identification of 31 different functions, plus two parity bits (I11 and I12) as shown in the following table:

	Code						
Function	I6	I7	I8	I9	I10	I11	I12
Approach azimuth	0	0	1	1	0	0	1
High rate approach azimuth	0	0	1	0	1	0	0
Approach elevation	1	1	0	0	0	0	1
Flare elevation	0	1	1	0	0	0	1
Back azimuth	1	0	0	1	0	0	1
360° azimuth	0	1	0	0	1	0	1
Basic data 1	0	1	0	1	0	0	0
Basic data 2	0	1	1	1	1	0	0
Basic data 3	1	0	1	0	0	0	0
Basic data 4	1	0	0	0	1	0	0
Basic data 5	1	1	0	1	1	0	0
Basic data 6	0	0	0	1	1	0	1
Auxiliary data A1	1	1	0	0	1	0	
Auxiliary data B1	0	1	0	1	1	1	
Auxiliary data C1	1	1	1	0	0	0	

3.11.4.5 Angle guidance parameters

Angle guidance information shall be encoded by the amount of time separation between the centres of the received TO and FRO scanning beam main lobes. The coding shall be interpreted in the airborne equipment as a linear function of time as follows:

(See Annex for data)

3.11.4.5.1

The values of the angle guidance parameters shall be as shown in the following table:

(See Annex for data)

3.11.4.5.2

The tolerances on the ground equipment scanning beam velocity and the time separation between TO and FRO pulses corresponding to zero degrees shall be sufficient to satisfy the accuracy requirements specified in 3.11.4.9 below.

3.11.4.5.3

The TO and FRO scan transmissions shall be symmetrically disposed about the mid-scan point listed in each of Tables A-2 through A-5 of Appendix A. The mid-scan point and the centre of the time interval between the TO and FRO scan transmissions shall coincide with a tolerance of plus or minus 10 microseconds.

3.11.4.6 Azimuth guidance functions

3.11.4.6.1

Each transmission of a guidance angle shall consist of a clockwise TO scan followed by a counterclockwise FRO scan as viewed from above the antenna. For approach azimuth functions, increasing angle values shall be in the direction of the TO scan. For the back azimuth functions, increasing angle values shall be in the direction of the FRO scan.

3.11.4.6.2

Sector signals. The transmission format of any azimuth function shall include time slots for airborne antenna selection, out-of-coverage indication, and test pulses as specified in Appendix A, Tables A-2 and A-3. The internal timing accuracy of the sector signals shall conform to the internal timing accuracy of the DPSK transitions specified in 3.11.4.3.4 above.

3.11.4.6.2.1

Ground equipment identification. The MLS providing services for a particular runway shall be identified by a four-character alphabetic designator starting with the letter M. This designator less the first letter shall be transmitted as a digital word as listed in Appendix A, Table A-7.

3.11.4.6.2.1.1

The signal shall be transmitted on the data channel into the approach and back azimuth coverage regions.

3.11.4.6.2.1.2

The code bit in the time slot previously allocated for the alternate (Morse code) ground equipment identification following the azimuth preamble shall be fixed in the “ZERO” state.

3.11.4.6.2.2

Airborne antenna selection signal. A signal for airborne antenna selection shall be transmitted as a “zero” DPSK signal lasting for a six-bit period. The signal shall be available throughout the coverage sector in which approach or back azimuth guidance is provided.

3.11.4.6.2.3

Azimuth out-of-coverage indication pulses. Where out-of-coverage indication pulses are used, they shall be:

a) greater than any guidance signal in the out-of-coverage sector;

b) at least 5 dB less than the fly-left (fly-right) clearance level within the fly-left (fly-right) clearance sector; and

c) at least 5 dB less than the scanning beam level within the proportional coverage region.

The duration of each pulse measured at the half amplitude point shall be at least 100 microseconds, and the rise and fall times shall be less than 10 microseconds.

3.11.4.6.2.3.1

If desired, it shall be permissible to sequentially transmit two pulses in each out-of-coverage indication time slot. Where the pulse pairs are used, the duration of each pulse shall be at least 50 microseconds and the rise and fall times shall be less than 10 microseconds.

3.11.4.6.2.3.2

The transmissions of out-of-coverage indication pulses radiated from antennas with overlapping coverage patterns shall be separated by at least 10 microseconds.

3.11.4.6.2.4 Ground radiated test signals

3.11.4.6.2.5 Clearance guidance

Where the proportional guidance sector provided is less than the minimum coverage specified in 3.11.5.2.2.1.1 a) and 3.11.5.2.2.2 a) below, clearance guidance shall be provided to supplement the coverage sector by the transmission of fly-left/fly-right clearance pulses in the formats for the approach azimuth, high rate approach azimuth and back azimuth functions. Alternatively, it shall be permissible to provide clearance guidance by permitting the scanning beam to scan beyond the designated proportional guidance sector to provide fly-left or fly-right clearance information as appropriate when the decoded angle exceeds the designated limits of proportional guidance coverage.

3.11.4.6.2.5.1

Clearance guidance information shall be provided by transmitting pairs of pulses within the angle scan time slots. One pair shall consist of one pulse adjacent to the start time of the scanning beam TO scan and one pulse adjacent to the stop time of the FRO scan. A second pair shall consist of one pulse adjacent to the stop time of the scanning beam TO scan, and one pulse adjacent to the start time of the FRO scan. The fly-right clearance pulses shall represent positive angles and the fly-left clearance pulses shall represent negative angles. The duration of each clearance pulse shall be 50 microseconds with a tolerance of plus or minus 5 microseconds. The transmitter switching time between the clearance pulses and the scanning beam transmissions shall not exceed 10 microseconds. The rise time at the edge of each clearance pulse not adjacent to the scanning beam shall be less than 10 microseconds.

3.11.4.6.2.5.2

The signal-in-space characteristics of the clearance guidance pulses shall be as follows:

a) within the fly-right clearance guidance sector, the fly-right clearance guidance signal shall exceed the scanning beam side lobes and all other guidance and out-of-coverage indication signals by at least 5 dB;

b) within the fly-left clearance guidance sector, the fly-left clearance guidance signal shall exceed the scanning beam side lobes and all other guidance and out-of-coverage indication signals by at least 5 dB;

c) within the proportional guidance sector, the clearance guidance signals shall be at least 5 dB below the scanning beam main lobe.

3.11.4.6.2.5.3

The power density of the clearance signal shall be as required in 3.11.4.10.1 below.

3.11.4.7 Elevation guidance functions

3.11.4.7.1

Scanning conventions. For the approach elevation function, increasing elevation guidance angles shall be in the upward direction. Zero elevation angle shall coincide with a horizontal plane through the respective antenna phase centre. Each guidance angle transmission shall consist of a TO scan followed by a FRO scan. The TO scan shall be in the direction of increasing angle values.

3.11.4.7.2

Sector signal. Provision for transmission of one out-of-coverage indication pulse shall be made in the format for the approach elevation function. Where an out-of-coverage indication pulse is used, it shall be: (1) greater than any guidance signal in the out-of-coverage indication sector and (2) at least 5 dB less than the guidance signals within the guidance sector. The elevation out-of-coverage indication timing shall be as shown in Appendix A, Table A-4. The duration of each pulse measured at the half amplitude points shall be at least 100 microseconds, and the rise and fall times shall be less than 10 microseconds.

3.11.4.7.2.1

If desired, it shall be permissible to sequentially transmit two pulses in each obstacle clearance indication time slot. Where pulse pairs are used, the duration of each pulse shall be at least 50 microseconds, and the rise and fall times shall be less than 10 microseconds.

3.11.4.8 Data functions

Provision shall be made in the MLS signal format for the transmission of basic data and auxiliary data.

3.11.4.8.1

Data transmission. Data shall be transmitted as specified in 3.11.4.4.3.1 above.

3.11.4.8.2

Basic data structure and timing. Basic data shall be encoded as 32-bit words consisting of a function preamble (12 bits) specified in 3.11.4.4 above, and data content as specified in Appendix A, Table A-7. The timing of the basic data words shall be as specified in Appendix A, Table A-6. The content, maximum interval between transmission of the same word and organization of the words shall be as specified in Appendix A, Table A-7. Data containing digital information shall be transmitted with the least significant bit first. The smallest binary number shall represent the lower absolute range limit with increments in binary steps to the upper absolute range limit specified in Appendix A, Table A-7.

3.11.4.8.2.1

Basic data contents. The data items specified in Appendix A, Table A-7 shall be defined as follows:

a) Approach azimuth antenna to threshold distance shall represent the minimum distance between the approach azimuth antenna phase centre to the vertical plane perpendicular to the centre line which contains the runway threshold.

b) Approach azimuth proportional coverage limit shall represent the limit of the sector in which proportional approach azimuth guidance is transmitted.

c) Clearance signal type shall indicate the method of providing the azimuth clearance signal.

d) Minimum glide path shall represent the lowest angle of descent along the zero-degree azimuth as defined in 3.11.1.

e) Back azimuth status shall represent the operational status of the back azimuth equipment.

f) DME status shall represent the operational status of the DME equipment.

g) Approach azimuth status shall represent the operational status of the approach azimuth equipment.

h) Approach elevation status shall represent the operational status of the approach elevation equipment.

i) Beamwidth shall represent, for a particular function, the antenna beamwidth as defined in 3.11.1.

j) DME distance shall represent the minimum distance between the DME antenna phase centre and the vertical plane perpendicular to the runway centre line which contains the MLS datum point.

k) Approach azimuth magnetic orientation shall represent the angle measured in the horizontal plane clockwise from Magnetic North to the zero-degree approach azimuth, originating from the approach azimuth antenna. The vertex of the measured angle shall be the approach azimuth antenna phase centre.

l) Back azimuth magnetic orientation shall represent the angle measured in the horizontal plane clockwise from Magnetic North to the zero-degree back azimuth, originating from the back azimuth antenna. The vertex of the measured angle shall be the back azimuth antenna phase centre.

m) Back azimuth proportional coverage limit shall represent the limit of the sector in which proportional back azimuth guidance is transmitted.

n) MLS ground equipment identification shall represent the last three characters of the system identification specified in 3.11.4.6.2.1. The characters shall be encoded in accordance with International Alphabet No. 5 (IA-5) using bits b1 through b6.

3.11.4.8.3

Auxiliary data organization and timing. Auxiliary data shall be organized into 76-bit words consisting of the function preamble (12 bits) as specified in 3.11.4.4, the address (8 bits) as specified in Appendix A, Table A-9, and data content and parity (56 bits) as specified in Appendix A, Tables A-10, A-11, A-12, A-13 and A-15. Three function identification codes are reserved to indicate transmission of auxiliary data A, auxiliary data B and auxiliary data C. The timing of the auxiliary data function shall be as specified in Appendix A, Table A-8. Two auxiliary data word formats shall be provided, one for digital data and one for alphanumeric character data. Data containing digital information shall be transmitted with the least significant bit first. Alpha characters in data words B1 through B39 shall be encoded in accordance with International Alphabet No. 5 (IA-5) using bits b1 to b5 with b1 transmitted first. Alphanumeric data characters in other data words shall be encoded in accordance with IA-5 using seven information bits, plus one even parity bit added to each character. Alphanumeric data shall be transmitted in the order in which they are to be read. The serial transmission of a character shall be with the lower order bit transmitted first and the parity bit transmitted last.

3.11.4.8.3.1

Auxiliary data A content. The data items contained in auxiliary data words A1 through A4 as specified in Appendix A, Table A-10 shall be defined as follows:

a) Approach azimuth antenna offset shall represent the minimum distance between the approach azimuth antenna phase centre and a vertical plane containing the runway centre line.

b) Approach azimuth antenna to MLS datum point distance shall represent the minimum distance between the approach azimuth antenna phase centre and the vertical plane perpendicular to the runway centre line which contains the MLS datum point.

c) Approach azimuth alignment with runway centre line shall represent the minimum angle between the zero-degree approach azimuth and the runway centre line.

d) Approach azimuth antenna co-ordinate system shall represent the co-ordinate system (planar or conical) of the angle data transmitted by the approach azimuth antenna.

e) Approach azimuth antenna height shall represent the vertical location of the antenna phase centre with respect to the MLS datum point.

f) Approach elevation antenna offset shall represent the minimum distance between the elevation antenna phase centre and a vertical plane containing the runway centre line.

g) MLS datum point to threshold distance shall represent the distance measured along the runway centre line from the MLS datum point to the runway threshold.

h) Approach elevation antenna height shall represent the vertical location of the elevation antenna phase centre with respect to the MLS datum point.

i) MLS datum point elevation shall represent the datum point elevation relative to mean sea level (msl).

j) Runway threshold height shall represent the vertical location of the intersection of the runway threshold and centre line with respect to the MLS datum point.

k) DME offset shall represent the minimum distance between the DME antenna phase centre and a vertical plane containing the runway centre line.

l) DME to MLS datum point distance shall represent the minimum distance between the DME antenna phase centre and the vertical plane perpendicular to the runway centre line which contains the MLS datum point.

m) DME antenna height shall represent the vertical location of the antenna phase centre with respect to the MLS datum point.

n) Runway stop-end distance shall represent the distance along centre line between the runway stop-end and the MLS datum point.

o) Back azimuth antenna offset shall represent the minimum distance between the back azimuth antenna phase centre and a vertical plane containing the runway centre line.

p) Back azimuth to MLS datum point distance shall represent the minimum distance between the back azimuth antenna and the vertical plane perpendicular to the runway centre line which contains the MLS datum point.

q) Back azimuth alignment with runway centre line shall represent the minimum angle between the zero-degree back azimuth and the runway centre line.

r) Back azimuth antenna coordinate system shall represent the coordinate system (planar or conical) of the angle data transmitted by the back azimuth antenna.

s) Back azimuth antenna height shall represent the vertical location of the antenna phase centre with respect to the MLS datum point.

3.11.4.8.3.2

Auxiliary data B content. Auxiliary data B words shall be defined as specified in Appendix A, Tables A-11 and A-13.

3.11.4.8.3.2.1

Microwave landing system/area navigation (MLS/RNAV) procedure data. Where required, auxiliary data words B1 through B39 shall be used to transmit data to support MLS/RNAV procedures. It shall be permissible to divide this procedure data into two separate data bases: one for transmission in the approach azimuth sector, the other for transmission in the back azimuth sector. Data for each procedure shall be transmitted in the data base for the coverage sector in which the procedure commences. Missed approach procedure data shall be included in the data base containing the associated approach procedure.

3.11.4.8.3.2.2

Procedure data base structure. Where used, each procedure data base shall be constructed as follows:

a) a map/CRC word shall identify the size of the data base, the number of procedures defined, and the cyclic redundancy check (CRC) code for validation of the data base;

b) procedure descriptor words shall identify all named approach and departure procedures within the data base; and

c) way-point data words shall define the location and sequence of way-points for the procedures.

3.11.4.9 System accuracy.

The accuracy standards specified herein shall be met on a 95 per cent probability basis unless otherwise stated.

3.11.4.9.1

MLS approach reference datum. The height of the MLS approach reference datum shall be 15 m (50 ft). A tolerance of plus 3 m (10 ft) shall be permitted.

3.11.4.9.2

MLS back azimuth reference datum. The height of the MLS back azimuth reference datum shall be 15 m (50 ft). A tolerance of plus 3 m (10 ft) shall be permitted.

3.11.4.9.3

The PFE shall be comprised of those frequency components of the guidance signal error at the output of the airborne receiver which lie below 0.5 rad/s for azimuth guidance information or below 1.5 rad/s for elevation guidance information. The control motion noise shall be comprised of those frequency components of the guidance signal error at the output of the airborne receiver which lie above 0.3 rad/s for azimuth guidance or above 0.5 rad/s for elevation guidance information. The output filter corner frequency of the receiver used for this measurement is 10 rad/s.

3.11.4.9.4

Approach azimuth guidance functions. At the approach reference datum, the approach azimuth function shall provide performance as follows:

a) the PFE shall not be greater than plus or minus 6 m (20 ft);

b) the PFN shall not be greater than plus or minus 3.5 m (11.5 ft);

c) the CMN shall not be greater than plus or minus 3.2 m (10.5 ft) or 0.1 degree, whichever is less.

3.11.4.9.4.1

At the approach reference datum, the PFE should not be greater than plus or minus 4 m (13.5 ft).

3.11.4.9.4.2

The linear accuracy specified at the reference datum shall be maintained throughout the runway coverage region specified in 3.11.5.2.2.1.2 below except where degradation is allowed as specified in 3.11.4.9.4.3 below

3.11.4.9.4.3

Degradation allowance. The approach azimuth angular PFE, PFN and CMN shall be allowed to degrade linearly to the limits of coverage as follows:

a) With distance. The PFE limit and PFN limit, expressed in angular terms at 37 km (20 NM) from the runway threshold along the extended runway centre line, shall be 2 times the value specified at the approach reference datum. The CMN limit shall be 0.1 degree at 37 km (20 NM) from the approach reference datum along the extended runway centre line at the minimum glide path angle.

b) With azimuth angle. The PFE limit and PFN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle, shall be 1.5 times the value on the extended runway centre line at the same distance from the approach reference datum. The CMN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle is 1.3 times the value on the extended runway centre line at the same distance from the approach reference datum.

c) With elevation angle. The PFE limit and PFN limit shall not degrade up to an elevation angle of 9 degrees. The PFE limit and PFN limit, expressed in angular terms at an elevation angle of 15 degrees from the approach azimuth antenna phase centre, shall be 2 times the value permitted below 9 degrees at the same distance from the approach reference datum and the same azimuth angle. The CMN limit shall not degrade with elevation angle.

d) Maximum CMN. The CMN limits shall not exceed 0.2 degree in any region of coverage.

3.11.4.9.4.3.1

The CMN should not exceed 0.1 degree in any region of coverage.

3.11.4.9.4.4

Maximum angular PFE and PFN. In any region within coverage, the angular error limits shall be as follows:

a) the PFE shall not exceed plus or minus 0.25 degree; and

b) the PFN shall not exceed plus or minus 0.15 degree.

3.11.4.9.5

Back azimuth guidance function. At the back azimuth reference datum, the back azimuth function shall provide performance as follows:

a) the PFE shall not be greater than plus or minus 6 m (20 ft);

b) the PFN component shall not be greater than plus or minus 3.5 m (11.5 ft);

c) the CMN shall not be greater than plus or minus 3.2 m (10.5 ft) or 0.1 degree, whichever is less.

3.11.4.9.5.1

Degradation allowance. The back azimuth angular PFE, PFN and CMN shall be allowed to degrade linearly to the limits of coverage as follows:

a) With distance. The PFE limit and PFN limit, expressed in angular terms at the limit of coverage along the extended runway centre line, shall be 2 times the value specified at the back azimuth reference datum. The CMN limit, expressed in angular terms at 18.5 km (10 NM) from the runway stop end along the extended runway centre line, shall be 1.3 times the value specified at the back azimuth reference datum.

b) With azimuth angle. The PFE limit and PFN limit, expressed in angular terms at plus or minus 20 degrees azimuth angle, shall be 1.5 times the value on the extended runway centre line at the same distance from the back azimuth reference datum. The CMN limit, expressed in angular terms at plus or minus 20 degrees azimuth angle, shall be 1.3 times the value on the extended runway centre line at the same distance from the back azimuth reference datum.

c) With elevation angle. The PFE limit and PFN limit shall not degrade up to an elevation angle of 9 degrees. The PFE limit and PFN limit, expressed in angular terms at an elevation angle of 15 degrees from the back azimuth antenna phase centre, shall be 2 times the value permitted below 9 degrees at the same distance from the back azimuth reference datum and the same azimuth angle. The CMN limit shall not degrade with elevation angle.

d) Maximum CMN. The CMN limits shall not exceed 0.2 degree in any region of coverage.

3.11.4.9.5.2

Maximum angular PFE and PFN. In any region within coverage, the angular error limits shall be as follows:

a) the PFE shall not exceed plus or minus 0.50 degree; and

b) the PFN shall not exceed plus or minus 0.30 degree.

3.11.4.9.6

Elevation guidance function. For equipment sited to provide a minimum glide path of nominally 3 degrees or lower, the approach elevation function shall provide performance at the approach reference datum as follows:

a) the PFE shall not be greater than plus or minus 0.6 m (2 ft);

b) the PFN shall not be greater than plus or minus 0.4 m (1.3 ft);

c) the CMN shall not be greater than plus or minus 0.3 m (1 ft).

3.11.4.9.6.1

Degradation allowance. The approach elevation angular PFE, PFN and CMN shall be allowed to degrade linearly to the limits of coverage as follows:

a) With distance. The PFE limit and PFN limit, expressed in angular terms at 37 km (20 NM) from the runway threshold on the minimum glide path, shall be 0.2 degree. The CMN limit shall be 0.1 degree at 37 km (20 NM) from the approach reference datum along the extended runway centre line at the minimum glide path angle.

b) With azimuth angle. The PFE limit and PFN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle, shall be 1.3 times the value on the extended runway centre line at the same distance from the approach reference datum. The CMN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle, shall be 1.3 times the value on the extended runway centre line at the same distance from the approach reference datum.

c) With elevation angle. For elevation angles above the minimum glide path or 3 degrees, whichever is less and up to the maximum of the proportional guidance coverage and at the locus of points directly above the approach reference datum the PFE limit, PFN limit and the CMN limit expressed in angular terms shall be allowed to degrade linearly such that at an elevation angle of 15 degrees the limits are 2 times the value specified at the reference datum. In no case shall the CMN directly above the reference datum exceed plus or minus 0.07 degree. For other regions of coverage within the angular sector from an elevation angle equivalent to the minimum glide path up to the maximum angle of proportional coverage the degradations with distance and azimuth angle specified in a) and b) shall apply.

d) The PFE, PFN and CMN limits shall not degrade with elevation angle in the region between the minimum glide path and 60 per cent of the minimum glide path. For elevation angles below 60 per cent of the minimum glide path and down to the limit of coverage specified in 3.11.5.3.2.1.2 below, and at the locus of points directly below the approach reference datum the PFE limit, the PFN limit and the CMN limit expressed in angular terms, shall be allowed to increase linearly to 6 times the value at the approach reference datum. For other regions of coverage within the angular sector from an elevation angle equivalent to 60 per cent of the minimum glide path angle value, and down to the limit of coverage the degradation with distance and azimuth angle specified in a) and b) shall apply. In no case shall the PFE be allowed to exceed 0.8 degree, or the CMN be allowed to exceed 0.4 degree.

e) Maximum CMN. For elevation angles above 60 per cent of the minimum glide path, the CMN limits shall not exceed 0.2 degree in any region of coverage.

3.11.4.9.6.2

Maximum angular PFE and PFN. In any region within coverage, the angular error limits for elevation angles above 60 per cent of the minimum glide path shall be as follows:

a) the PFE shall not exceed plus or minus 0.25 degree; and

b) the PFN shall not exceed plus or minus 0.15 degree.

3.11.4.9.6.3

The limit expressed in angular terms on the linear degradation of the PFE limit, the PFN limit and the CMN limit at angles below 60 per cent of the minimum glide path and down to the limit of coverage should be 3 times the value permitted at the approach reference datum.

3.11.4.9.6.4

Maximum CMN. For elevation angles above 60 per cent of the minimum glide path, the CMN limits should not exceed 0.1 degree in any region of coverage.

3.11.4.9.6.5

The PFE should not exceed 0.35 degree, and the CMN should not exceed 0.2 degree.

3.11.4.9.6.6

Approach elevation equipment sited to provide a minimum glide path higher than 3 degrees shall provide angular accuracies not less than those specified for equipment sited for a 3-degree minimum glide path within the coverage volume.

3.11.4.10 Power density

3.11.4.10.1

The power density for DPSK, clearance and angle guidance signals shall be at least the values shown in the following table under all operational weather conditions at any point within coverage except as specified in 3.11.4.10.2 below.

(See Annex for data)

3.11.4.10.2

The power density of the approach azimuth angle guidance signals shall be greater than that specified in 3.11.4.10.1 above by at least:

a) 15 dB at the approach reference datum;

b) 5 dB for one degree or 9 dB for 2 degree or larger beamwidth antennas at 2.5 m (8 ft) above the runway surface, at the MLS datum point, or at the farthest point of the runway centre line which is in line of sight of the azimuth antenna.

3.11.5 Ground equipment characteristics

3.11.5.1 Synchronization and monitoring

The synchronization of the time-division-multiplexed angle guidance and data transmissions which are listed in 3.11.4.3.3 above shall be monitored.

3.11.5.1.1

Residual radiation of MLS functions. The residual radiation of an MLS function at times when another function is radiating shall be at least 70 dB below the level provided when transmitting.

3.11.5.2 Azimuth guidance equipment

3.11.5.2.1

Scanning beam characteristics. Azimuth ground equipment antennas shall produce a fan-shaped beam which is narrow in the horizontal plane, broad in the vertical plane and which is scanned horizontally between the limits of the proportional guidance sector.

3.11.5.2.1.1

Co-ordinate system. Azimuth guidance information shall be radiated in either conical or planar co-ordinates.

3.11.5.2.1.2

Antenna beamwidth. The antenna beamwidth shall not exceed 4 degrees.

3.11.5.2.1.3

Scanning beam shape. The minus 10-dB points on the beam envelope shall be displaced from the beam centre by at least 0.76 beamwidth, but not more than 0.96 beamwidth.

3.11.5.2 2 Coverage

3.11.5.2.2.1

Approach azimuth. The approach azimuth ground equipment shall provide guidance information in at least the following volumes of space:

3.11.5.2.2.1.1

Approach region.

a) Laterally, within a sector of 80 degrees (normally plus and minus 40 degrees about the antenna boresight) which originates at the approach azimuth antenna phase centre.

b) Longitudinally, from the approach azimuth antenna to 41.7 km (22.5 NM).

c) Vertically, between:

1) a lower conical surface originating at the approach azimuth antenna phase centre and inclined upward to reach, at the longitudinal coverage limit, a height of 600m (2 000 ft) above the horizontal plane which contains the antenna phase centre; and

2) an upper conical surface originating at the approach azimuth antenna phase centre inclined at 15 degrees above the horizontal to a height of 6 000 m (20 000 ft).

3.11.5.2.2.1.2

Runway region.

a) Horizontally within a sector 45 m (150 ft) each side of the runway centre line beginning at the stop end and extending parallel with the runway centre line in the direction of the approach to join the minimum operational coverage region as described in 3.11.5.2.2.1.3 below.

b) Vertically between:

1) a horizontal surface which is 2.5 m (8 ft) above the farthest point of the runway centre line which is in line of sight of the azimuth antenna; and

2) a conical surface originating at the azimuth ground equipment antenna inclined at 20 degrees above the horizontal up to a height of 600 m (2 000 ft).

3.11.5.2.2.1.2.1

The lower level of the coverage in the runway region should be 2.5 m (8 ft) above the runway centre line.

3.11.5.2.2.1.2.2

Where required to support automatic landing, roll-out or take-off, the lower level of coverage in the runway region shall not exceed 2.5 m (8 ft) above the runway centre line.

3.11.5.2.2.1.3

Minimum operational coverage region.

a) Laterally, within a sector of plus and minus 10 degrees about the runway centre line which originates at the MLS datum point.

b) Longitudinally, from the runway threshold in the direction of the approach to the longitudinal coverage limit specified in 3.11.5.2.2.1.1 b).

c) Vertically, between:

1) a lower plane which contains the line 2.5 m (8 ft) above the runway threshold and is inclined upward to reach the height of the surface specified in 3.11.5.2.2.1.1 c) 1) at the longitudinal coverage limit; and

2) the upper surface specified in 3.11.5.2.2.1.1 c) 2).

3.11.5.2.2.1.4

The approach azimuth ground equipment should provide guidance vertically to 30 degrees above the horizontal.

3.11.5.2.2.1.5

The minimum proportional guidance sector shall be as indicated in as follows:

(see Annex for data)

3.11.5.2.2.2

Back azimuth. The back azimuth ground equipment shall provide information in at least the following volume of space:

a) Horizontally, within a sector plus or minus 20 degrees about the runway centre line originating at the back azimuth ground equipment antenna and extending in the direction of the missed approach at least 18.5 km (10 NM) from the runway stop end.

b) Vertically, in the runway region between:

1) a horizontal surface 2.5 m (8 ft) above the farthest point of runway centre line that is in line of sight of the back azimuth antenna; and

2) a conical surface originating at the back azimuth ground equipment antenna inclined at 20 degrees above the horizontal up to a height of 600 m (2 000 ft).

c) Vertically, in the back azimuth region between:

1) a conical surface originating 2.5 m (8 ft) above the runway stop end, inclined at 0.9 degree above the horizontal; and

2) a conical surface originating at the back azimuth ground equipment antenna, inclined at 15 degrees above the horizontal up to a height of 3 000 m (10 000 ft).

3.11.5.2.2.2.1

The back azimuth facility should provide guidance information to 30 degrees above the horizontal.

3.11.5.2.2.2.2

The minimum proportional guidance sector shall be plus or minus 10 degrees about the runway centre line.

3.11.5.2.3.1

Monitor and control

The approach azimuth and back azimuth monitor systems shall cause the radiation of their respective functions to cease and a warning shall be provided at the designated control points if any of the following conditions persist for longer than the periods specified:

a) there is a change in the ground equipment contribution to the mean course error such that the PFE at the approach reference datum or in the direction of any azimuth radial exceeds the limits specified in 3.11.4.9.4 and 3.11.4.9.5 and (for simplified MLS configuration) in 3.11.3.4 for a period of more than one second or (for simplified MLS configuration) for a period of more than six seconds;

b) there is a reduction in the radiated power to less than that necessary to satisfy the requirements specified in 3.11.4.10.1 and 3.11.4.6.2.5.2 for a period of more than one second;

c) there is an error in the preamble DPSK transmissions which occurs more than once in any one-second period;

d) there is an error in the TDM synchronization of a particular azimuth function such that the requirement specified in 3.11.4.3.2 is not satisfied, and this condition persists for more than one second.

3.11.5.2.3.2

Design and operation of the monitor system shall cause radiation to cease and a warning shall be provided at the designated control points in the event of failure of the monitor system itself.

3.11.5.2.3.3

The period during which erroneous guidance information is radiated, including period(s) of zero radiation, shall not exceed the periods specified in 3.11.5.2.3.1. Attempts to clear a fault by resetting the primary ground equipment or by switching to standby ground equipment shall be completed within this time. If the fault is not cleared within the time allowed, the radiation shall cease. After shutdown, no attempt shall be made to restore service until a period of 20 seconds has elapsed.

3.11.5.2.4 Integrity and continuity of service requirements for MLS azimuth

3.11.5.2.4.1

The probability of not radiating false guidance signals shall not be less than 1 - 0.5 × 10-9 in any one landing for an MLS azimuth intended to be used for Categories II and III operations.

3.11.5.2.4.2

The probability of not radiating false guidance signals should not be less than 1 - 1.0 × 10-7 in any one landing for an MLS azimuth intended to be used for Category I operations.

3.11.5.2.4.3

The probability of not losing the radiated guidance signal shall be greater than:

a) 1 - 2 × 10-6 in any period of 15 seconds for an MLS azimuth intended to be used for Category II or Category IIIA operations (equivalent to 2 000 hours mean time between outages); and

b) 1 - 2 × 10-6 in any period of 30 seconds for an MLS azimuth intended to be used for the full range of Category III operations (equivalent to 4 000 hours mean time between outages).

3.11.5.2.4.4

The probability of not losing the radiated guidance signal should exceed 1 - 4 × 10-6 in any period of 15 seconds for an MLS azimuth intended to be used for Category I operations (equivalent to 1 000 hours mean time between outages).

3.11.5.2.5 Ground equipment accuracy

3.11.5.2.5.1

The ground equipment contribution to the mean course error shall not exceed an error equivalent to plus or minus 3 m (10 ft) at the MLS approach reference datum.

3.11.5.2.5.2

The ground equipment contribution to the CMN at the reference datum should not exceed 1 m (3.3 ft) or 0.03 degree, whichever is less, on a 95 per cent probability basis.

3.11.5.2.6 Siting

3.11.5.2.6.1

Normally, the approach azimuth ground equipment antenna shall be located on the extension of the runway centre line beyond the stop end and shall be adjusted so that the vertical plane containing the zero degree course line will contain the MLS approach reference datum. Siting of the antenna shall be consistent with safe obstacle clearance SARPs in Annex 14.

3.11.5.2.6.2

The back azimuth ground equipment antenna shall normally be located on the extension of the runway centre line at the threshold end, and the antenna shall be adjusted so that the vertical plane containing the zero degree course line will contain the back azimuth reference datum.

3.11.5.3 Elevation guidance equipment

3.11.5.3.1

Scanning beam characteristics. The elevation ground equipment antenna shall produce a fan-shaped beam that is narrow in the vertical plane, broad in the horizontal plane and which is scanned vertically between the limits of the proportional guidance sector.

3.11.5.3.1.1

Co-ordinate system. Approach elevation guidance information shall be radiated in conical coordinates.

3.11.5.3.1.2

Antenna beamwidth. The antenna beamwidth shall not exceed 2.5 degrees.

3.11.5.3.1.3

Scanning beam shape. The minus 10-dB points on the beam envelope shall be displayed from the centre line by at least 0.76 beamwidth but not more than 0.96 beamwidth.

3.11.5.3.2 Coverage

3.11.5.3.2.1

Approach elevation. The approach elevation ground equipment shall provide proportional guidance information in at least the following volume of space.

3.11.5.3.2.1.1

Approach region

a) Laterally, within a sector originating at the elevation antenna phase centre which has an angular extent at least equal to the proportional guidance sector provided by the approach azimuth ground equipment at the longitudinal coverage limit.

b) Longitudinally, from the elevation antenna in the direction of the approach to 37 km (20 NM) from threshold.

c) Vertically, between:

1) a lower conical surface originating at the elevation antenna phase centre and inclined upward to reach, at the longitudinal coverage limit, a height of 600 m (2 000 ft) above the horizontal plane which contains the antenna phase centre; and

2) an upper conical surface originating at the elevation antenna phase centre and inclined 7.5 degrees above the horizontal up to a height of 6 000 m (20 000 ft).

3.11.5.3.2.1.1.1

The approach elevation ground equipment should provide proportional guidance to angles greater than 7.5 degrees above the horizontal when necessary to meet operational requirements.

3.11.5.3.2.1.2

Minimum operational coverage region.

a) Laterally, within a sector originating at the MLS datum point, of plus and minus 10 degrees about the runway centre line;

b) Longitudinally, 75 m (250 ft) from the MLS datum point in the direction of threshold, to the far coverage limit specified in 3.11.5.3.2.1.1 b);

c) Vertically, between the upper surface specified in 3.11.5.3.2.1.1 c) 2), and the higher of:

1) a surface which is the locus of points 2.5 m (8 ft) above the runway; or

2) a plane originating at the MLS datum point and inclined upward to reach, at the longitudinal coverage limit, the height of the surface specified in 3.11.5.3.2.1.1 c) 1).

3.11.5.3.3 Monitor and control

3.11.5.3.3.1

The approach elevation monitor system shall cause the radiation of its respective functions to cease and a warning shall be provided at the designated control point if any of the following conditions persist for longer than the periods specified:

a) there is a change in the ground equipment contribution to the mean glide path error component such that the PFE at the approach reference datum or on any glide path consistent with published approach procedures exceeds the limits specified in 3.11.4.9.6 and (for simplified MLS configuration) in 3.11.3.4 for a period of more than one second or (for simplified MLS configuration) for a period of more than six seconds;

b) there is a reduction in the radiated power to less than that necessary to satisfy the requirements specified in 3.11.4.10.1 for a period of more than one second;

c) there is an error in the preamble DPSK transmissions which occurs more than once in any one-second period;

d) there is an error in the TDM synchronization of a particular elevation function such that the requirement specified in 3.11.4.3.2 is not satisfied and this condition persists for more than one second.

3.11.5.3.3.2

Design and operation of the monitor system shall cause radiation to cease and a warning shall be provided at the designated control points in the event of failure of the monitor system itself.

3.11.5.3.3.3

The period during which erroneous guidance information is radiated, including period(s) of zero radiation, shall not exceed the periods specified in 3.11.5.3.3.1. Attempts to clear a fault by resetting the primary ground equipment or by switching to standby ground equipment shall be completed within this time. If the fault is not cleared within the time allowed, radiation shall cease. After shutdown, no attempt shall be made to restore service until a period of 20 seconds has elapsed.

3.11.5.3.4 Integrity and continuity of service requirements for MLS approach elevation

3.11.5.3.4.1

The probability of not radiating false guidance signals shall not be less than 1 - 0.5 × 10-9 in any one landing for an MLS approach elevation intended to be used for Categories II and III operations.

3.11.5.3.4.2

The probability of not radiating false guidance signals should not be less than 1 - 1.0 × 10-7 in any one landing on MLS approach elevation intended to be used for Category I operations.

3.11.5.3.4.3

The probability of not losing the radiated guidance signal shall be greater than 1 - 2 × 10-6 in any period of 15 seconds for an MLS approach elevation intended to be used for Categories II and III operations (equivalent to 2 000 hours mean time between outages).

3.11.5.3.4.4

The probability of not losing the radiated guidance signal should exceed 1 - 4 × 10-6 in any period of 15 seconds for an MLS approach elevation intended to be used for Category I operations (equivalent to 1 000 hours mean time between outages).

3.11.5.3.5 Ground equipment accuracy

3.11.5.3.5.1

The ground equipment contribution to the mean glide path error component of the PFE shall not exceed an error equivalent to plus or minus 0.3 m (1 ft) at the approach reference datum.

3.11.5.3.5.2

The ground equipment contribution to the CMN at the reference datum should not exceed 0.15 m (0.5 ft) on a 95 per cent probability basis.

3.11.5.3.6 Siting

3.11.5.3.6.1

The approach elevation ground equipment antenna shall be located beside the runway. Siting of the antennas shall be consistent with obstacle clearance Standards and Recommended Practices in Annex 14.

3.11.5.3.6.2

The approach elevation ground equipment antenna shall be sited so that the asymptote of the minimum glide path crosses the threshold at the MLS approach reference datum.

3.11.5.3.6.2.1

The minimum glide path angle is normally 3 degrees and should not exceed 3 degrees except where alternative means of satisfying obstacle clearance requirements are impractical.

3.11.5.3.6.2.2

The approach elevation ground equipment antenna should be sited so that the height of the point which corresponds to the decoded guidance signal of the minimum glide path above the threshold does not exceed 18 m (60 ft).

3.11.5.3.6.3

When ILS and MLS simultaneously serve the same runway, the ILS reference datum and the MLS approach reference datum should coincide within a tolerance of 1 m (3 ft).

3.11.5.4 Data coverage and monitoring

3.11.5.4.1 Basic data

3.11.5.4.1.1

The basic data words 1, 2, 3, 4 and 6 shall be transmitted throughout the approach azimuth coverage sector.

3.11.5.4.1.2

Where the back azimuth function is provided, basic data words 4, 5 and 6 shall be transmitted throughout the approach azimuth and back azimuth coverage sectors.

3.11.5.4.2 Auxiliary data

3.11.5.4.2.1

Auxiliary data words A1, A2 and A3 shall be transmitted throughout the approach azimuth coverage sector.

3.11.5.4.2.2

Where the back azimuth function is provided, auxiliary data words A3 and A4 shall be transmitted throughout the approach azimuth and back azimuth coverage sectors.

3.11.5.4.2.3

When provided, auxiliary data B words shall be transmitted throughout the approach azimuth sector, except that the words comprising the back azimuth procedure data base shall be transmitted throughout the back azimuth sector.

3.11.5.4.2.4

If the back azimuth function is provided, the appropriate auxiliary data B words should be transmitted.

3.11.5.4.3 Monitor and control

3.11.5.4.3.1

The monitor system shall provide a warning to the designated control point if the radiated power is less than that necessary to satisfy the DPSK requirement specified in 3.11.4.10.1 above.

3.11.5.4.3.2

If a detected error in the basic data radiated into the approach azimuth coverage occurs in at least two consecutive samples, radiation of these data, approach azimuth and elevation functions shall cease.

3.11.5.4.3.3

If a detected error in the basic data radiated into the back azimuth coverage occurs in at least two consecutive samples, radiation of these data and the back azimuth function shall cease.

3.11.5.5 Distance measuring equipment

3.11.5.5.1

DME information shall be provided at least throughout the coverage volume in which approach and back azimuth guidance is available.

3.11.5.5.2

DME information should be provided throughout 360° azimuth if operationally required.

3.11.6 Airborne equipment characteristics

3.11.6.1 Angle and data functions

3.11.6.1.1 Accuracy

3.11.6.1.1.1

Where the DPSK and scanning beam signal power densities are the minimum specified in 3.11.4.10.1 above, the airborne equipment shall be able to acquire the signal and any decoded angle signal shall have a CMN not exceeding 0.1 degree, except that the back azimuth guidance function CMN shall not exceed 0.2 degree.

3.11.6.1.1.2

Where the radiated signal power density is high enough to cause the airborne receiver noise contribution to be insignificant, the airborne equipment shall not degrade the accuracy of any decoded angle guidance signal by greater than plus or minus 0.017 degree (PFE), and plus or minus 0.015 degree (azimuth), and plus or minus 0.01 degree (elevation) CMN.

3.11.6.1.1.3

In order to obtain accurate guidance to 2.5 m (8 ft) above the runway surface, the airborne equipment shall produce less than 0.04 degree CMN with the power densities indicated in 3.11.4.10.2 b) above.

3.11.6.1.2 Dynamic range

3.11.6.1.2.1

The airborne equipment shall be able to acquire the signal and the performance in 3.11.6.1.1.2 above shall be met where the power density of any of the radiated signals has any value between the minimum specified in 3.11.4.10.1 above up to a maximum of minus 14.5 dBW/m2.

3.11.6.1.2.2

The receiver performance shall not degrade beyond the specified limits when the maximum differential levels permitted in 3.11.6.1.2.1 above exist between signal power densities of individual functions.

3.11.6.1.3 Receiver angle data output filter characteristics

3.11.6.1.3.1

For sinusoidal input frequencies, receiver output filters shall not induce amplitude variations or phase lags in the angle data which exceed those obtained with a single pole low-pass filter with a corner frequency of 10 rad/s by more than 20 per cent.

3.11.6.1.4

Adjacent channel spurious response. (see Annex for data).

—END—

CIVIL AVIATION AUTHORITY OF NEW ZEALAND

NOTIFICATION OF COMPLIANCE WITH OR DIFFERENCES FROM ANNEX 10 VOLUME I AERONAUTICAL TELECOMMUNICATIONS (RADIO NAVIGATION AIDS)
(including all amendments up to and including Amendment 81)

To: The Secretary General
International Civil Aviation Organisation
999 University Street
Montreal, Quebec
Canada H3C 5H7

The following differences will exist on 23 November 2006 between the regulations and/or practices of **NEW ZEALAND** and the provisions of Annex 10 Volume I, including all amendments up to and including Amendment 81:

Annex Provision	Details of Difference	Remarks
2.7.1	Some Non-Directional Beacons and Locator beacons are not the subject of periodic flight tests.	Stand alone NDB are only flight tested as required for special or post accident/incident inspection.
3.1.3.3	Because of siting problems and terrain limitations some localizer do not meet Category I facility performance criteria for off course clearance.	Details of limitations are published in the AIP.
3.1.4	Not a mandatory requirement for ILS localizer receiving systems fitted to New Zealand registered aircraft.	
3.1.5.3	Because of siting problems and terrain limitations some glide paths do not meet Category I facility performance criteria up to 8 degrees in azimuth on each side of the centre line.	Details of limitations are published in the AIP.
3.1.7.6.2.1*	Due to topographical limitations middle markers are not always at 1 050 plus or minus 150 metres from the landing threshold.	
3.1.7.6.3.1*	Due to topographical limitations outer markers are not always located between 6.5 and 11.1 km from the landing threshold.	
3.3.8	Not a mandatory requirement for VOR receiving systems fitted to New Zealand registered aircraft.	
3.4.8.2*	Mandatory standard.	
3.4.8.4*	Mandatory standard.	

3.5.3.6.3 (a)	The beacon identity code signal must be transmitted at least once but not more than twice every 40 seconds with the code groups equally spaced.	
3.5.4.7.2.1 (a)	Certain remotely sited DME do not provide an indication at a control point.	
3.5.4.7.2.3*	Mandatory standard.	

* denotes a Recommended Practice

Steven Blair June 2006
Senior Co-ordinator ICAO Liaison