1. Objective

1.1. This directive is part of the CNS inspector handbook.

1.2. This directive provides guidance for evaluating and approving all categories of Instrument Landing Systems (ILS) services.

2. General

2.1. The ILS provides precision guidance signals to aircraft in the last stages of approach and landing. For this purpose the equipment needs a high level of integrity, accuracy and reliability. Other auxiliary equipment is used to support the main equipment.

2.2. Instrument Landing Systems facility performances are classified as Category I, Category II or Category III, in ascending order of accuracy, integrity and reliability.

2.3. Full definitions of these facility performance categories may be found in ICAO Annex 10, Volume 1, Chapter 3.1.1

2.4. ILS is Navigation Radio Station.

2.5. Under article 35(a) to the Israeli Air Navigation Law 2011 any Aeronautical Telecommunication Service is required to have CAAI approval before being established or used.

2.6. Navigation Radio Station is specifically included in the definition of Aeronautical Telecommunication Service in Article 1 to the ANL, 2011.

2.7. This document sets out the requirements for approval of ILS Navigation Radio Stations established or used within Israel to provide ATS services.

2.8. Abbreviations

ANL	-	Air Navigation Law
ANR	-	Air Navigation Regulations
ATC	-	Air Traffic Control
ANS	-	Air Navigation Service
ATS	-	Air Traffic Service
DDM	-	Difference in depth of modulation
DOC	-	Designated Operational Coverage

3. Reference Material ,Form& Job-Aids

3.1. Law & Regulation

3.1.1. ANL 2011 articles 35(a) & 27(a) & 29

3.1.2. ANR Operation of Aircraft and Rules of Flight, 1981 - 66(c).

3.1.3. ANR Safety at Aerodromes of the Airport Authority, 1992 - 3.

3.2. CAAI AP & Directives

3.2.1. ANS 4.0.005 – CNS Inspector Handbook Manual

3.2.2. AP 1.7.005 / 2.7.005 - ATS equipment installation, maintenance, operation & approval

3.2.3. ANS 1.7.024 –DME approval.

3.3. ICAO annexes & documents

3.3.1. ICAO Annex 10 Aeronautical Telecommunications Volume I- Radio Navigation Aids.

3.3.2. ICAO Annex 10 Aeronautical Telecommunications Volume V (Aeronautical Radio Frequency Spectrum Utilization).

3.3.3. ICAO Annex 11 Air Traffic Services.

3.3.4. ICAO Doc 8071 Volume I – Testing of Ground-Based Radio Navigation System

3.3.5. ICAO Doc 9712 - Training Manual Part E-2 Air Traffic Safety Electronics Personnel (ATSEP)

Note: This document incorporates the relevant SARPs from ICAO Annex 10 and Annex 11 together.

3.4. Forms & Job-Aids – none

CAAI Form ANSF 1.7.005-2 - Instrument Landing System (ILS) Data Form

4. Process

4.1. Technical Requirements

This section sets out the Engineering Requirements for all Instrument Landing Systems (ILS) intended for use in the provision of an ATS.

4.1.1. General Requirements

4.1.1.1 Safety objective

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

4.1.1.2 SARPs Compliance

In addition to the requirements below, ILS systems shall comply with the SARPs in ICAO Annex 10 Volume 1 Chapter 2 General Provisions or Radio Navigation Aids and Chapter 3 Section 3.1 Specification for ILS.

4.1.1.3 Radio Spectrum Management

4.1.1.3.1. The equipment and systems shall be installed, operated and maintained in compliance with the terms of specific location dependent or general frequency assignment(s) and the terms and conditions of the Approval granted in respect of the ATS being provided.

4.1.1.3.2. The DOCs associated with the frequency assignments for ATS Communications Facilities and Radio Navigation and Landing Aids at aerodromes, shall be published in the Remarks column of sections AD of the AIP respectively

4.1.1.3.3. All Aeronautical Radio Stations shall be suitably licensed by the ministry of communication.

4.1.1.3.4. Failure to renew the ministry of communication radio license will invalidate the associated CAAI Approval and the associated frequency assignment will be withdrawn. Renewal after the withdrawal of the ministry of communication radio license will be treated as a new application.

4.1.1.3.5. For new installations that operate on aeronautical frequency assignments, initial applications to establish an Aeronautical Radio Station shall be made to the CAAI, which will trigger the process with the ministry of communication.

4.1.1.3.6. All frequency assignments shall be coordinated and registered in ICAO data base.

4.1.1.3.7. Inspection of Aeronautical Radio Stations - The equipment and systems at aeronautical radio stations and associated records shall be inspected by CAAI Inspector.

4.1.1.3.8. Demonstration of compliance will be required. This may include measurements to verify transmitter frequency, modulation depth, transmitter output power and a determination of effective radiated power. The ATS Provider is expected to provide this information.

4.1.1.3.9. The equipment shall transmit only on the frequency assigned by the CAAI and as appears in the schedule to the radio license issued under the Wireless Telegraphy order (1972).

4.1.1.4 Integrity and Continuity of Service

4.1.1.4.1. The ILS shall meet the ICAO Annex 10 Volume 1 SARPs for Integrity and Continuity of Service found in section 3.1 of Chapter 3.

4.1.1.4.2. Maintenance shall be prescribed in accordance with the Integrity Analysis.

4.1.1.5 Serviceability Indicators

4.1.1.5.1. ATC directly responsible for ILS operations shall be provided with information on the operational status of radio navigation services essential for approach, landing at the aerodrome(s) with which they are concerned, on a timely basis consistent with the use of the service(s) involved.

4.1.1.5.2. Where status information is reliant upon a visual status indicator, then an audible alarm should be provided which indicates that the visual indicator has changed state.

4.1.1.6 Failure of Status Communications

4.1.1.6.1. Permitting a status communications failure to shut down the ILS without a warning could unnecessarily remove the ILS signal when the aircraft is in a critical phase of the approach.

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

4.1.1.6.3. For Category II and III systems, failure of the status communication shall not cause an immediate ILS close-down.

4.1.1.6.4. For Category I systems, it is acceptable to consider status communication failure as part of the Continuity of Service assessment.

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

4.1.1.6.6. If the ILS is configured to close-down the system after a delay following status communications failure, the delay must be long enough for the actions in paragraph 4.1.1.6.2 to be completed.

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

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

4.1.1.7 Category and Status Unit

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

Note: The precise method of calculation used by the Category and Status Unit will depend on the ILS equipment from which it derives its inputs. The display category will need to be supported by the integrity and Continuation of Service assessment.

4.1.1.7.2. The unit shall have integrity as determined by hazard analysis.

4.1.1.7.3. Any change of calculated category shall cause an audible alarm to ATC.

4.1.1.7.4. The unit shall have provision to limit the maximum category output to the display.

4.1.1.7.5. If the calculated category falls, then the category must remain at the lower value until upgraded manually by an authorized person except as prescribed in paragraph 4.1.1.7.6

4.1.1.7.6. If a Far Field Monitor alarm or ILS pre-alarm causes a category fall, then the category may be automatically upgraded as long as no other alarms are present.

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

4.1.1.8 Interlocking

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

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

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

4.1.1.9 Provision of Standby Equipment

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

4.1.1.9.2. Other categories should have standby equipment with automatic changeover.

4.1.1.10 Standby Battery Power

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

Recommendation: Category I facilities should have standby batteries.

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

4.1.1.11 **Power supply switch-over times for ILS systems** (Annex 10 Volume I Att C)

Type of runway	Aids requiring power	Maximum switch-over times (sec)
Precision approach, Category I	ILS localizer ILS glide path	10
Precision approach, Category II	ILS localizer ILS glide path	0
Precision approach, Category III	(same as Category II)	

4.1.1.12 Localizer Back Beam

Facilities designed to radiate a back beam are not permitted.

4.1.1.13 Offset Localizers

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

4.1.1.14 Requirements for ILS and ILS/DME Identity Keying

ICAO Annex 10 requires that ILS and DME systems shall radiate an identity code when they are operationally available.

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

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

4.1.1.14.1. Keying Sequence

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

A complete keying sequence shall occupy approximately 40 seconds.

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

4.1.1.14.2. Master Equipment

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

4.1.1.14.3. System Operation

- If at any time the master equipment fails, the slave equipment shall revert to totally independent keying.
- If the master keyer is subsequently returned to service, the slave equipment shall automatically return to normal slave operation, with no requirement for manual resetting at the slave equipment.
- When a localizer is acting as slave to a DME it shall key 3/4. The DME keying shall be synchronized to occur where there is an interval in the localizer keying. If the DME fails, the localizer shall revert to 4/4 keying with no gap where the DME identity would have been.
- When a DME is slave to a localizer, it shall key 1/4. If the localizer fails, the DME shall continue to key 1/4, i.e. the DME shall key itself at the correct rate for an independent DME.
- Regardless of which equipment is master or slave, a failure in one equipment shall neither leave the associated equipment without identity nor cause it to close down.

4.1.1.14.4. Slave Monitor Information

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

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

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

4.1.1.14.5. Independent Operation

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

4.1.1.14.6. Equipment Out of Service

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

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

Note 1: Radiation of continuous un-keyed tone is permitted.

Note 2: During commissioning and engineering flight inspections, the normal identity code may be radiated for short periods at the navaid inspector's request.

The use of the code TST for extended periods of testing shall no longer be permitted.

4.1.1.15 ILS Radio Noise Monitoring

4.1.1.15.1. Radio signals from extraneous sources may interfere with the guidance information of an ILS signal. The problem becomes more important for Cat II and Cat III systems, where a higher level of integrity is required than for Cat I.

4.1.1.15.2. Interference monitoring and data recording has been carried out on Cat II and Cat III airfields for many years, allowing trends in the background interference level to be analyzed. For this trend analysis to remain valid, it is essential that new monitoring equipment is compatible with the previous system of measurement. For this reason, this document is highly prescriptive in certain areas.

4.1.1.15.3. At present, techniques for monitoring interference on an operational channel are only in the development phase. The existing system assumes that the interference is equally distributed throughout the localizer band. Hence all channels except the active ILS frequency are monitored.

4.1.1.15.4. Advanced equipment may be used which for example, can recognize interference on the operational channel or examine the complete frequency band with no gaps. However, the equipment shall also comply with all requirements in this document.

This requirement applies to all ILS localizers operated at Cat II or Cat III.

4.1.1.16 Critical Areas

4.1.1.16.1. Localizer and Glidepath critical areas shall be clearly marked and identified. The marking shall be visible day and night and shall help ensure that no person or vehicle may enter the areas without the permission of ATC.

4.1.1.16.2. Where fencing is used to mark the critical areas, the operator shall ensure the ILS continues to operate in accordance with the requirements of paragraph 4.1.3 Flight Inspection Requirements.

4.1.1.16.3. Details of the Localizer and Glidepath critical areas shall be included in the unit operations and maintenance manual together with any appropriate procedures.

4.1.1.17 Sensitive Areas

4.1.1.17.1. Localizer and Glidepath sensitive areas shall be set in relation to the aircraft type that causes the greatest dynamic bends to the course structure, whilst operating at the aerodrome during Low Visibility Procedures.

4.1.1.17.2. Details of the Localizer and Glidepath sensitive areas shall be included in the unit operations and maintenance manual, together with any appropriate procedures.

4.1.1.18 Computer Simulation

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

a) Proof that the version of software being used is the latest issue, OR recent written confirmation from the software manufacturer that the version being used has no known safety related problems ;

b) Proof that the person making the simulation has received formal training in the use of the simulation program;

c) Evidence to support that the model is suitable for the intended simulation; and

d) Evidence to support the correlation of the modeling tool with far field measurement.

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

4.1.1.19 Grass Height

4.1.1.19.1. The height of grass in certain areas on the aerodrome may affect the performance of aeronautical navigational equipment and visual aids, especially the Instrument Landing System (ILS).

4.1.1.19.2. In damp or wet conditions the radiated signal received by an aircraft or the signal received by the ILS field monitors may be distorted, affecting both the integrity and continuity of service of the system. The effect of grass on the ILS signal depends on the:

a) type of grass (broad or narrow leaf);

b) height of the grass and density of growth;

c) water content within, or water from dew or rain on, the leaves; and

d) height and type of aerials (transmitting and monitor).

It is not practicable to give exact grass heights that would cover all systems and environments; however, the following have been shown to be acceptable:

e) ILS glidepath

A grass height of up to 100 mm is considered to be acceptable from the glidepath aerial to approximately 5 m beyond the monitors. A grass height of up to 200 mm is considered to be acceptable beyond this point up to the limit of the glidepath critical area.

f) ILS localizer

A grass height of up to 200 mm may be considered acceptable within the critical area.

4.1.1.19.3. Other heights may also be suitable; however, advice from the Service Provider must always be sought before implementation of any deviation from these grass heights.

Use of Second Hand Equipment

4.1.1.19.4. Second hand equipment may be installed subject to the following conditions:

4.1.1.19.5. The equipment shall be examined by the manufacturer's quality representative or by an agent designated by the manufacturer. A written declaration shall show:

4.1.1.19.6. The equipment is in a satisfactory state for further service; and

4.1.1.19.7. There are no outstanding safety-related modifications.

4.1.1.19.8. Glidepath aerials shall be brand new or factory refurbished and re-tested to the original factory test specification; and

4.1.1.19.9. All aerial feeder cables shall be renewed.

4.1.1.20 Ground testing

Ground testing shall be carried out in accordance with the requirements in paragraph 4.2.

4.1.1.21 Flight Inspection

Flight inspection shall be carried out in accordance with the requirements in paragraph 4.3.

4.2. Ground Testing

4.2.1. The primary purposes of ground testing are to ensure that the ILS radiates a signal meeting the requirements of Annex 10 and to confirm correct monitor operation.

4.2.2. Ground test requirements for localizers, glide paths are listed in Tables I, II.

4.2.3. Independence of ground measurements and monitor equipment

In most cases, these measurements will be made using equipment other than the monitors that are a part of the normal installation. This is because a primary value of ground tests is to confirm overall monitor performance, and it is therefore desirable to make corroborative checks on monitor indications using independent equipment. However, especially where large aperture antenna systems are used, it is often not possible to place the monitor sensors in such a position that the phase relationship observed in the far field could be observed at the monitor sensing point. Therefore, it is recommended that these check measurements be made at more realistic positions. Significant differences in the correlation between the check measurements and monitor indications should always be investigated and resolved.

4.2.4. Correlation between field and monitor indications

When checks are made on the monitor indications by means of portable test equipment, the following effects should be taken into account:

4.2.4.1 *Aperture effect*: The extent of the near-field is a function of the aperture of the radiating antenna system.

4.2.4.1.1. *Localizer:* For apertures up to 30 m (100 ft), negligible error due to the near-field effect will be introduced if measurements are made at points beyond a ten-aperture (twenty apertures preferred) distance from the localizer antenna. For larger aperture antennas, a minimum distance of twenty apertures is recommended to obtain readings that are more accurate.

4.2.4.1.2. *Glide path:* The equipment is normally adjusted so that the signal phase relationships existing on the runway center line at threshold or beyond are correct. For this reason, the ILS reference datum represent a good position for glide path measurement. If possible, positions on the extended runway center line should be used. However, any location is suitable if a good correlation between the measured and far-field conditions is obtained.

4.2.4.2 *Ground constants:* In the near-field region the measurement accuracy may be adversely affected by changes in ground constants.

Satisfactory drainage and soil stabilization would help to achieve stability.

4.2.4.3 *Diffracted and reflected energy:* The alignment and displacement sensitivity of the localizer and the glide path may be affected by the presence of diffracted and reflected energy. This should be taken into account when such characteristics are determined for the first time.

4.2.5. Correlation between ground and flight tests

4.2.5.1 Whenever possible, the correlation between simultaneous or nearly simultaneous ground and airborne measurement results on the same or related parameters should be analyzed. Good correlation will usually result in increased confidence in both measurements, and when rigorously applied, may be the basis for extending maintenance or test intervals.

4.2.5.2 Typically, the necessary conditions for correlation of measurement results include the ready availability of proper ground maintenance test equipment, traceable calibration programs for ground and airborne test equipment, availability of commissioning and recent test reports, and similar training between ground and airborne personnel on the meaning and value of measurement correlation. If feasible, a meeting between ground maintenance and airborne test personnel before the measurements is desirable, particularly if dissimilar test generators and receivers are used. If measurements do not agree within reasonable tolerances and cannot be resolved, actions such as tightening monitor alarm points, declassifying the facility, or removing it from service should be considered.

Table I - Ground test requirements for ILS performance Categories I, II, and III **localizers**

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance *(See Note 1)*	Uncertainty	Periodicity
Orientation	3.1.3.1		Orientation	Correct		Annual
Frequency	3.1.3.2.1	4.2.12	Frequency	Frequency single: 0.005% Dual: 0.002% 5 kHz< Separation <14 kHz	0.001% 0.0005%	Annual
Spurious modulation	3.1.3.2.3		DDM, Deviation	<0.005 DDM peak-to-peak	0.001 DDM	Quarterly
Coverage (usable distance)	3.1.3.3.1	4.2.13	Power	As set at commissioning. *(See Note 2).*	1 dB	Quarterly
Course structure (Category III only)	3.1.3.4	4.2.8, 4.2.9	DDM	As described in Annex 10.	0.001 DDM	Quarterly
Carrier modulation	3.1.3.5.1	4.2.15	DDM, Depth	Within 10 μA of the modulation balance value.	0.001 DDM	Quarterly
Balance				18-22%	0.2%	
Depth						
Carrier modulation frequency	3.1.3.5.3	4.2.14	Frequency	Cat I: ±2.5% Cat II: ±1.5% Cat III: ±1%	0.1%	Annual
Carrier modulation harmonic content (90 Hz)	3.1.3.5.3 d)	4.2.17	Total 2nd harmonic	<10% <5% (Cat III)	0.5%	Annual
Carrier modulation harmonic content (150 Hz)	3.1.3.5.3 e)		Total 2nd harmonic	<10% <5% (Cat III)	0.5%	Annual
Unwanted modulation	3.1.3.5.3.2		Ripple	Modulation depth <0.5%	0.1%	Semi-annual

Table I - Ground test requirements for ILS performance Categories I, II, and III **localizers**

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance *(See Note 1)*	Uncertainty	Periodicity
Phase of modulation tones	3.1.3.5.3.3	4.2.18 to 4.2.20	LF phase	Cat I, II: <20° Cat III: <10°	4° 2°	Annual
Phase of modulation tones dual frequency systems (each carrier and between carriers)	3.1.3.5.3.4					
Phasing of alternative systems	3.1.3.5.3.5			Cat I, II, nominal: ±20° Cat III nominal: ±10°	4° 2°	
Sum of modulation depths	3.1.3.5.3.6	4.2.15	Modulation depth	Modulation depth <95%	2%	Quarterly
Sum of modulation depths when using radiotelephony communications	3.1.3.5.3.7	4.2.15	Modulation depth	65% ±10° <Modulation depth <78% beyond 10°	2%	Monthly
Course alignment	3.1.3.6.1	4.2.8, 4.2.9	DDM, Distance	Cat I: <10.5 m. *(See Note 2).* Cat II: <7.5 m Cat III: < 3 m	0.3 m	I - Quarterly II- Monthly III - Weekly
Displacement sensitivity	3.1.3.7	4.2.10	DDM/meter	0.00145 nominal. *(See Note 2).* Cat I, II: ±17% Cat III: ±10%	±3% ±2%	I, II -Quarterly III - Monthly
Peak modulation depth	3.1.3.8.3.2		Modulation depth	<50%	2%	Quarterly
Audio frequency characteristic	3.1.3.8.3.3		Modulation depth	±3dB	0.5 dB	Annual
Identification tone frequency	3.1.3.9.2		Tone frequency	1020 ±50 Hz	5 Hz	Annual
Identification modulation depth		4.2.16	Modulation depth	As commissioned	1 %	Quarterly

Table I - Ground test requirements for ILS performance Categories I, II, and III **localizers**

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance *(See Note 1)*	Uncertainty	Periodicity
Identification speed	3.1.3.9.4		Tone frequency	1020 ±50 Hz	1 %	
Identification repetition rate			Time	As commissioned.		
Phase modulation	3.1.3.5.4	4.2.21 to 4.2.23	Peak deviation	Limits given in FM Hz/PM radians: *(see Note 5)*. 90 Hz 150 Hz (Difference Hz)		3 years
				Cat I: 135/1.5 135/0.9 45	10 Hz	
				Cat II: 60/0.66 60/0.4 20	5 Hz	
				Cat III: 45/0.5 45/0.3 15	5 Hz	
Monitoring				*See Note 2.*		I - Quarterly II - Monthly III – Weekly *See Notes 3 & 4*
Course shift	3.1.3.11.2	4.2.25	DDM, Distance	Monitor must alarm for a shift in the main course line from the runway center line equivalent to or more than the following distances at the ILS reference datum.		
				Cat I: 10.5 m (35 ft)	2 m	
				Cat II: 7.5 m (25 ft)	1 m	
				Cat III: 6.0 m (20 ft)	0.7 m	
Change in displacement sensitivity	3.1.3.11.2 f)	4.2.26		Monitor must alarm for a change in displacement sensitivity to a value differing from the nominal value by more than:		
				Cat I: 17%	±3%	

Table I - Ground test requirements for ILS performance Categories I, II, and III **localizers**

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance *(See Note 1)*	Uncertainty	Periodicity
				Cat II: 17% Cat III: 17% Required only for certain types of localizer	±3% ±3%	
Clearance signal	3.1.3.11.2.1		DDM	Monitor must alarm when the off-course clearance cross-pointer deflection falls below 150 µA anywhere in the off-course coverage area	±5 µA	I - Quarterly II - Monthly III – Weekly *See Notes 3 & 4*
Reduction in power	3.1.3.11.2 d) & e)	4.2.27	Power field strength	Monitor must alarm either for a power reduction of 3 dB, or when the coverage falls below the requirement for the facility, whichever is the smaller change.	±1 dB relative	*Periodicity*
Total time, out-of-tolerance radiation	3.1.3.11.3	4.2.24	Time	For two-frequency localizers, the monitor must alarm for a change of ±1dB in either carrier, unless tests have proved that use of the wider limits above will not cause unacceptable signal degradation (>150 µA in clearance sector). Cat I: 10 S Cat II:5 S Cat III: 2 S	±5 µA 0.2S	

Notes:

1. In general, the equipment settings should not be modified if the listed parameters are within 50 per cent of tolerance. See ICAO DOC 8071 Volume I chapter 4 para. 4.2.54 and 4.2.55.

2. After the commissioning, flight check for the localizer, ground measurements of course alignment, displacement sensitivity, and power output should be made, both for normal and monitor alarm conditions. These measurements should be noted and used as reference in subsequent routine check measurements.

3. The periodicity for monitor tests may be increased if supported by an analysis of integrity and stability history.

4. These tests also apply to those parameters measured by the far-field monitor, if installed.

5. This measurement applies to the difference in peak frequency deviation between the separate measurements of the undesired 90 Hz FM (or equivalent PM) and the 150 Hz FM, using the filters specified in ICAO DOC 8071 Volume I chapter 4 table in 4.2.23.

Table II - Ground test requirements for ILS performance Categories I, II, and III **glide paths**

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance *(See Note 1)*	Uncertainty	Periodicity
Orientation	3.1.5.1.1		Orientation	Correct		Annual
Path angle	3.1.5.1.2.2	4.2.29 to 4.2.31	DDM, Angle	*See Note 2.* Cat I: Within 7.5% of nominal angle Cat II: Within 7.5% of nominal angle Cat III: Within 4% of nominal angle	Cat I: 0.75% Cat II: 0.75% Cat III: 0.4%	Quarterly
Frequency	3.1.5.2.1	4.2.34	Frequency	Single 0.005% Dual 0.002% 4 kHz<Separation <32 kHz	0.001% 0.0005% 0.0005%	Annual
Unwanted modulation	3.1.5.2.3		DDM	±0.02 DDM peak-to-peak	0.004 DDM	Semi-annual
Coverage (usable distance)	3.1.5.3	4.2.35	Power	As commissioned	1 dB	Quarterly
Carrier modulation *(See Note 3)*	3.1.5.5.1	4.2.37	Modulation depth	0.002 DDM 37.5% to 42.5% for each tone	0.001 DDM 0.5%	Quarterly
Balance						
Depth						
Carrier modulation frequency	3.1.5.5.2 a), b) & c)	4.2.36	Frequency of modulation tones	Cat I: ±2.5% Cat II: ±1.5% Cat III: ±1%	0.1%	Annual
Carrier modulation harmonic content (90 Hz)	3.1.5.5.2 d)	4.2.38	Total 2nd harmonic	<10% <5% (Cat III)	1%	Annual
Carrier modulation harmonic content (150 Hz)	3.1.5.5.2 e)		Total 2nd harmonic	<10% <5% (Cat III)	1%	Annual
Unwanted amplitude modulation	3.1.5.5.2.2		Ripple	<1%	0.1%	Annual

Table II - Ground test requirements for ILS performance Categories I, II, and III **glide paths**

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance *(See Note 1)*	Uncertainty	Periodicity
Phase of modulation tones	3.1.5.5.3	4.2.39	LF phase	Cat I, II: <20° Cat III: <10°	4° 2°	Annual
Phase of modulation tones dual frequency systems (each carrier and between carriers)	3.1.5.5.3.1					
Phase of modulation tones, alternative systems	3.1.5.5.3.2			Cat I, II, nominal: ±20° Cat III nominal: ±10°	4° 2°	
Displacement sensitivity	3.1.5.6	4.2.32	DDM, Angle	Refer to Annex 10, Volume I, 3.1.5.6 See Note 2.	Cat I: 2.5% Cat II: 2.0% Cat III: 1.5%	Quarterly Quarterly Monthly
Phase modulation	3.1.5.5.4	4.2.21 to 4.2.23	Peak deviation	Limits given in FM Hz/PM radians: *(see Note 5)*. 90 Hz · 150 Hz · (Difference Hz) Cat I: 150/1.66 · 150/1.0 · 50 Cat II, III: 90/1.0 · 90/0.6 · 30	10 Hz 10 Hz	3 years
Monitoring (*See Note 4)*				*See Note 2.*	±4 µA	Cat I, II - Quarterly Cat III -Monthly
Path angle	3.1.5.7.1 a)	4.2.42	DDM, Angle	Monitor must alarm for a change in angle of 7.5% of the promulgated angle.		

Table II - Ground test requirements for ILS performance Categories I, II, and III **glide paths**

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance *(See Note 1)*	Uncertainty	Periodicity
Change in displacement sensitivity	3.1.5.7.1 d), e)	4.2.43	DDM, Angle	Cat I: Monitor must alarm for a change in the angle between the glide path and the line below the glide path at which 75 μA is obtained, by more than 3.75% of path angle. Cat II: Monitor must alarm for a change in displacement sensitivity by more than 25%. Cat III: Monitor must alarm for a change in displacement sensitivity by more than 25%.		
Reduction in power	3.1.5.7.1 b), c)	4.2.44	Power	Monitor must alarm either for a power reduction of 3 dB, or when the coverage falls below the requirement for the facility, whichever is the smaller change. For two-frequency glide paths, the monitor must alarm for a change of ±1dB in either carrier, unless tests have proved that use of the wider limits above will not cause unacceptable signal degradation.	±1 dB ±0.5 dB	Cat I, II - Quarterly Cat III -Monthly
Clearance signal	3.1.5.7.1 g)		DDM, Angle	Monitor must alarm for DDM <0.175 below path clearance area		
Total time of out-of-tolerance radiation	3.1.5.7.3.1	4.2.24	Time	Cat I: 6 S Cat II, III:2 S		

Notes:

1. In general, the equipment settings should not be modified if the listed parameters are within 50 per cent of the given tolerances. See ICAO DOC 8071 Volume I chapter 4 para 4.2.54 and 4.2.55.

2a) After the commissioning, flight check for the glide path, ground measurements of glide path angle, displacement sensitivity, and clearance below path, may be made, both for normal and monitor alarm conditions. These measurements may be used as reference in subsequent routine check measurements.

2b) After the commissioning, flight check for the glide path and ground measurements of the glide path power should be made, both for normal and monitor alarm conditions. These measurements may be used as reference in subsequent routine check measurements.

3. The tolerances given are for routine checks only. All parameters should be set to nominal values at the time of commissioning.

4. The periodicity for monitor tests may be increased if supported by an analysis of integrity and stability history.

5. This measurement applies to the difference in peak frequency deviation between the separate measurements of the undesired 90 Hz FM (or equivalent PM) and the 150 Hz FM, using the filters specified in ICAO DOC 8071 Volume I chapter 4 table in 4.2.23

4.2.6. Localizer

4.2.6.1 Localizer course alignment

4.2.6.1.1. The measurement of localizer course alignment should be carried out in the far-field region of the localizer. There are several alternative methods that may be employed. One method, which is widely used, employs portable field test equipment which is located at pre-surveyed points on the runway center line or on the extended center line. The course structure at the position selected for these measurements should be stable. By using this test equipment, the position of the course line relative to the runway center line may be determined. This method enables single-point measurement of the course line to be obtained and is considered to be adequate for Category I and II facilities.

4.2.6.1.2. For Category III facilities see ICAO DOC 8071 chapter 4 para 4.2.9

4.2.6.2 Displacement sensitivity

Displacement sensitivity of the localizer is measured with portable test equipment located at surveyed positions in the far-field where the course structure is known and stable. These test positions are typically on opposite sides of the runway center line at the edge of the half-course sector. The test equipment reading obtained at each position is recorded, and the displacement sensitivity is calculated in units of DDM/meter as the sum of the absolute value of the two DDM values, divided by the linear distance between the two surveyed points

4.2.6.3 Off-course clearance

The procedure to be adopted for ground measurement of off-course clearance will vary from station to station depending upon the layout of the airfield. Typically, pre-surveyed points will be provided at intervals throughout the ±35-degree forward coverage area of the ILS localizer. In the case of localizers operating on the two-frequency principle, additional points may be provided at azimuths where the two patterns have equal signal strength on either side of the center line. The portable test equipment is positioned at the pre-surveyed points and the off-course clearance signal conditions recorded. The results will be analyzed to assess the stability and repeatability of the clearance parameters. For localizers providing clearance beyond the ±35-degree coverage sector, additional readings should be made. The spacing of the points may be greater here than the spacing employed within the coverage sector.

4.2.6.4 Carrier frequency

This is usually measured at the transmitter output using a dummy load tap or test point connected to a frequency counter or frequency meter. For a two frequency system, the carriers are arranged symmetrically about the assigned frequency. Checks on those systems should be made of each frequency and of the difference between the two carriers.

4.2.6.5 Output power

The power into the antenna system may be measured using a wattmeter, preferably of the through-line type that is capable of indicating direct and reflected power. During installation, it may be convenient to relate this power measurement to field strength at the runway threshold. This can be done by measuring field strength on the course line at the threshold (at a height of 4 m (13 ft) for Category II and III) and at the same time recording the power into the antenna system. Subsequently, the power should be reduced by 3 dB and the resulting threshold field strength again recorded.

4.2.6.6 Modulation depth (90/150 Hz)

Modulation depth is probably one of the most difficult quantities to measure to the required accuracy, and only high precision instruments should be used. The technique used to measure the modulation depths should preferably be one which analyses the waveform with both modulating tones present. If the measurement can only be made with one tone present, care should be taken to ensure that:

4.2.6.6.1. The individual tone amplitude is not affected by the removal or the addition of the other tone;

4.2.6.6.2. The modulator remains linear with both tones present; and

4.2.6.6.3. The harmonic content of the tone is as low as possible.

4.2.6.7 Modulation depth (1020 Hz)

Measurement of the modulation depth of the 1020 Hz identification tone can be carried out by wave analyzer comparison between the modulation depth of the 90 Hz tone and the 1020 Hz tone or by portable test equipment, which can measure it directly. The wave analyzer is tuned to 90 Hz and the scale amplitude is noted. The wave analyzer is then tuned to 1020 Hz and the modulation depth of the 1020 Hz is adjusted to the appropriate proportion of the 90 Hz reading.

4.2.6.8 Harmonic content of the 90 and 150 Hz tones

This is measured at the transmitter cabinet using a detector feeding a wave analyzer from which a value is obtained on a root mean square (RMS) calculation basis. For future checks a distortion factor meter may be used, however, this can indicate a higher value of distortion than that contributed by the harmonics themselves.

4.2.6.9 Monitoring system operation

This test is essentially a check on the overall executive operation of the monitor systems. The total time periods specified are never-to-be-exceeded limits and are intended to protect aircraft in the final stages of approach against prolonged or repeated periods of localizer guidance outside the monitor limits. For this reason they include not only the initial period of outside tolerance operation but also the total of any or all periods of out-of-tolerance radiation, which might occur during action-to-restore service, for example, in the course of consecutive monitor functioning and consequent changeover(s) to localizer equipment(s) or elements thereof. The intention is that no guidance outside the monitor limits be radiated after the time periods given, and that no further attempt be made to restore service until a period in the order of 20 seconds has elapsed.

4.2.6.9.1. Monitor course alignment alarm

The purpose of this check is to ensure that the monitor executive action occurs for a course alignment shift of the distances specified in Table I. One of the following methods may be used:

a) The alignment of the ILS localizer course line may be offset by the operation of a control in either the transmitter cabinet or antenna system, as may be appropriate to the particular installation under examination. At the point where the monitor system indicates that an alarm condition has been reached, measurement of the resulting far-field course alignment should be accomplished. This test should, where possible, be carried out at the time of the course alignment check.

b) The measurement of course alignment alarm may be carried out by the application of a precision ILS signal generator to the monitor input. The correlation between the resulting alarm indication and the location of the localizer course line in the far-field should be carried out periodically.

4.2.6.9.2. Monitor displacement sensitivity alarm

The purpose of this check is to ensure that the monitor displacement sensitivity alarm action occurs for changes in displacement sensitivity specified in Table I. One of the following methods may be used:

a) The ILS localizer course width may be adjusted by operating a suitable control (width control) until the monitor system indicates that a wide alarm condition has been reached. When an alarm is indicated, the displacement sensitivity in the far-field should be measured. Following this measurement, the width control setting needed to initiate the narrow alarm is selected and displacement sensitivity again measured using the ILS test method as described above.

b) The measurement of displacement sensitivity alarm may be carried out by the application of a precision ILS signal generator to the monitor input. The correlation between the resulting alarm indication and the displacement sensitivity in the far-field should be carried out periodically.

4.2.6.9.3. Monitor power reduction alarm

The purpose of this check is to ensure that the monitor power reduction alarm action occurs for the change in power specified in Table I. The ILS localizer output power is reduced by operation of a suitable control (transmitter output power) until the monitor system reaches an alarm condition. At this point, the output power should be measured. A calibrated signal generator input into the monitor can also be used for this measurement.

4.2.7. Glide Path

4.2.7.1 Path angle

4.2.7.1.1. The recommended means of measurement of a glide path angle (θ) is by flight test. However, it may be measured on the ground either at the normal monitoring location or at a distance of at least 400 m (1200 ft.) from the transmitting antenna, preferably on the extended center line of the runway.

4.2.7.1.2. The measurement location used will depend on the type of glide path, its monitoring system and the local site conditions. Where the monitoring system is attached to the glide path antenna structure, or where the signal at the monitor location may be affected by local conditions, e.g. accumulation of snow, change in ground characteristics, etc., then the angle measurements should be made at least 300 m (1000 ft.) in front of the glide path as suggested above. In any case, it is preferable at the time of commissioning to measure the glide path parameters at this location for future reference.

4.2.7.2 Displacement sensitivity

The recommended means of measurement of displacement sensitivity is by flight test. However, ground measurement of this parameter should be made using the method described for the glide path angle, but test antenna heights should be determined additionally at which 0.0875 DDM occurs below and above the glide path. The heights obtained will enable figures to be derived for the representative standard upper and lower half-sector displacement sensitivities at the position at which the checks are made.

4.2.7.3 Clearance below path

Ground measurement of below path clearance is not normally required for null reference systems. For other systems the measurement may be made as described for the glide path angle. Test antenna heights should be determined and DDM values recorded to enable a curve to be plotted showing DDM between 0.3θ and the lower half-sector. From the curve of DDM versus angle plotted, the representative standard clearance below path performance may be obtained. A value of 0.22 DDM should be achieved at an angle not less than 0.3θ above the horizontal. However, if it is achieved at an angle above 0.45θ, the DDM value should not be less than 0.22 at least down to 0.45θ.

4.2.7.4 Carrier frequency

This test is the same as for the localizer (para. 4.2.6.4)

4.2.7.5 Output power

This test is the same as for the localizer (para 4.2.6.5), except that the threshold power measurements should be made at the zero DDM height.

4.2.7.6 Modulation depth (90/150 Hz)

This test is the same as for the localizer (para 4.2.6.6).

4.2.7.7 Harmonic content of the 90 and 150 Hz tone

This test is the same as for the localizer (para 4.2.6.8).

4.2.7.8 Monitor system operation

This test is the same as for the localizer (para 4.2.6.9).

4.2.7.9 Monitor angle alarms

The purpose of this check is to ensure that the monitor executive action occurs for a change in glide path angle specified in Table II. Some facilities may require monitor executive limits to be adjusted to closer limits than those specified in the table because of operational requirements. One of the following methods may be used:

a) The alignment of the ILS glide path may be offset by the operation of a control in either the transmitter cabinet or antenna system, as may be appropriate, to the particular installation under examination. At the point where the monitor system indicates that an alarm condition has been reached, measurement of the resulting far-field path alignment should be accomplished. This test should, where possible, be carried out at the time of the path alignment check.

b) The measurement of the path alignment alarm may be carried out by the application of a precision ILS signal generator to the monitor input. The correlation between the resulting alarm indication and the location of the glide path in the far-field should be carried out periodically.

4.2.7.10 Monitor displacement sensitivity alarm

The purpose of this check is to ensure that the monitor displacement sensitivity alarm action occurs for changes in displacement sensitivity specified in Table II. One of the following methods may be used:

a) The ILS glide path width is adjusted by operating a suitable control (width control) until the monitor system indicates that a wide or narrow alarm condition has been reached. When an alarm is indicated, the displacement sensitivity in the far-field should be measured. Following this measurement, the width control setting needed to initiate the alternate alarm is selected and displacement sensitivity again measured using the test method as described above.

b) The measurement of displacement sensitivity alarm may be carried out by the application of a precision ILS signal generator to the monitor input. The correlation between the resulting alarm indication and the displacement sensitivity in the far-field should be carried out periodically.

4.2.7.11 Monitor power reduction alarm

This test is the same as for the localizer (para 4.2.6.9.3).

4.3. **Flight Inspection**

4.3.1. The purpose of flight testing is to confirm the correctness of the setting of essential signal-in-space parameters, determine the operational safety and acceptability of the ILS installation, and periodically correlate signal patterns observed in flight and from the ground. Since flight testing instrumentation varies greatly, only a general description of the test methodology is given below.

4.3.2. Flight tests constitute in-flight evaluation and sampling of the radiated signals in the static operating environment. The signals-in-space are evaluated under the same conditions as they are presented to an aircraft receiving system and after being influenced by factors external to the installation, e.g. site conditions, ground conductivity, terrain irregularities, metallic structures, propagation effects, etc. Because dynamic conditions, such as multipath due to taxiing or overflying aircraft or moving ground vehicles, are continually changing, they cannot be realistically flight-tested. Instead, these effects on the signal-in-space are controlled by the establishment of critical and sensitive areas and by operational controls.

4.3.3. Flight test performance parameters

Flight test requirements for localizers, glide paths are listed in Tables III & IV.

4.3.4. Schedules of flight inspection

4.3.4.1 Site proving inspection (S).

This flight inspection is conducted at the option of the responsible authority, and its purpose is to determine the suitability of a proposed site for the permanent installation of an ILS facility. It is often performed with portable localizer or glide path equipment. The inspection is sufficiently extensive to determine the effects that the ground environment will have on the facility performance. The site-proving inspection is not a recurring type inspection.

4.3.4.2 Commissioning and categorization inspections (C,C).

The basic type of inspection, serving either of these purposes, is a comprehensive inspection designed to obtain complete detailed data relating to facility performance and to establish that the facility, as installed, will meet the operational requirements. This type of inspection is conducted under the following circumstances:

a) Commissioning:

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

i) Initial.

Prior to initial commissioning of an ILS;

ii) Recommissioning.

After relocation of an antenna or installation of a different type of antenna or of transmitting equipment;

b) Categorization.

At the time when categorization of an ILS is required.

4.3.4.3 Periodic inspections (P).

These are regularly scheduled flight inspections conducted to determine whether the facility performance continues to meet standards and satisfy its operational requirements. Typically, the transmitters are flown in both normal and alarm conditions, and path structure is evaluated. If the available flight inspection equipment dictates that the structure cannot be measured during every periodic inspection (e.g. theodolite equipment is not available), then the structure should be measured every other periodic inspection at a minimum.

4.3.4.4 Special flight inspection.

This is a flight inspection required by special circumstances, e.g. major equipment modifications, reported or suspected malfunctions, etc. During special flight inspections it is usually necessary to inspect only those parameters that have or might have an effect on performance; however, in some cases it may be economically advantageous to complete the requirements for a routine or annual inspection. It is impractical to attempt to define all of the purposes for which special inspections will be conducted or the extent of inspection required for each. Special inspections may also be requested as a result of ground checks of the performance, or flight inspection, in which case the nature of the suspected malfunction will guide the inspection requirements.

4.3.4.5 Flight inspections following ground maintenance activities.

Certain ground maintenance activities, as well as changes in the ground environment near radiating antenna systems, require a confirming flight inspection. This is because ground measurements cannot duplicate the operational use of the signals in some respects. Although engineering judgment should be used in individual cases to prevent unnecessary costly airborne testing, the following changes typically require a confirming inspection:

a) A change in the operating frequency;

b) Significant changes in the multipath environment within the antenna pattern limits;

c) Replacement of antenna arrays or antenna elements; and

d) Replacement of radio frequency components, such as bridges, phasers, amplifiers, and cabling, when ground measurements prior to and after the changes are not available, or the results do not support restoration without a flight inspection

4.3.4.6 Tolerances

4.3.4.6.1. A tolerance of +20 days is applicable to the prescribed intervals. Operators shall strive to ensure that flight inspection takes place as closely as possible to the prescribed intervals. If the previous inspection lasted more than one day, the interval shall be calculated from the date when the inspection started.

4.3.4.6.2. Flight inspections may be made up to 7 days earlier than the due date without affecting the due date for the next inspection.

4.3.4.6.3. If an inspection is made more than 7 days before the due date, the date of subsequent inspections shall be advanced.

4.3.4.7 Delays due to Adverse Weather or security situation

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

4.3.4.7.2. Reduced inspection requirements:

4.3.4.7.3. Localizer: part orbit ± 35° at approximately 6 nautical miles for both transmitters.

4.3.4.7.4. Glidepath: Level slice starting at the edge of the DOC, at the height normally used for such a flight on the facility, for both transmitters.

4.3.4.8 Supplementary Flight Inspections

4.3.4.8.1. A supplementary flight inspection must be made 90 days ±20 days after a periodic flight inspection if at that inspection any parameter was found outside the flight inspection tolerances stated in Tables III & IV below and subsequently adjusted.

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

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

4.3.4.8.4. A supplementary flight inspection may be requested by the CAAI at any time if the following conditions arise:

- CAAI inspector considers that any aspect of maintenance is not being correctly carried out;
- An inspection of equipment monitor records, which may be requested at any time by the CAAI, shows any evidence of instability;
- Changes have been made within the safeguarded areas); and
- A periodic inspection has shown any unusual, though not necessarily out of tolerance, aberrations in the course structure.

Table III - Flight inspection requirements and tolerances for localizer Category (Cat) I, II and III

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance	Uncertainty	Inspection type		
						S	C, C	P
Identification	3.1.3.9	4.3.12	Morse code	Proper keying, clearly audible to the limit of the range.	Subjective assessment		X	X
Voice feature	3.1.3.8	4.3.13	Audibility,DDM	Clear audio level similar to identification, no effect on course line	Subjective assessment		X	X
Modulation	N/A		DDM	See Note 1.				X
Balance	3.1.3.5	4.3.14	Modulation	0.002 DDM	0.001 DDM	X	X	
Depth	3.1.3.5	4.3.15	Depth	18% to 22%	±0.5%	X	X	X
Displacement sensitivity	3.1.3.7	4.3.16 to 4.3.20	DDM	Cat I: Within 17% of the nominal value Cat II: Within 17% of the nominal value Cat III: Within 10% of the nominal value See Note 2.	±3 μA ±3 μA ±2 μA For nominal 150 μA input	X	X	X
Off-course clearance	3.1.3.7.4	4.3.21, 4.3.22	DDM	On either side of course line, linear increase to 175 μA, then maintenance of 175 μA to 10°. Between 10° and 35°, minimum 150 μA. Where coverage required outside of ±35°, minimum of 150 μA except in back course sector.	±5 μA For nominal 150 μA input	X	X	X
High-angle clearance	N/A	4.3.23 to 4.3.25	DDM	Minimum of 150 μA.		X	X	
Course alignment accuracy	3.1.3.6	4.3.26 to 4.3.28	DDM, Distance, Angle	Equivalent to the following displacements at the ILS reference datum: Cat I: ±10.5 m (35 ft) Cat II: ±7.5 m (25 ft) [±4.5 m (15 ft) for those Cat II localizers which are adjusted and maintained within ±4.5 m] Cat III: ±3 m (10 ft)	Cat I: ±2 m Cat II: ±1 m Cat III: ±0.7m	X	X	X
Phasing		4.3.39, 4.3.40	DDM	≤10 μA of the modulation balance value. See Note 3.	±1 μA	X	X	X
DDM increase linear	3.1.3.7.4			>180 μA (Linear increase from 0 to >180 μA)			X	X

Table III - Flight inspection requirements and tolerances for localizer Category (Cat) I, II and III

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance	Uncertainty	Inspection type		
						S	C, C	P
Voice no interference to basic function	3.1.3.8		DDM, Speech	No interference			X	X
Phase to avoid voice null on dual frequency systems	3.1.3.8.3.1		Speech	No nulls.			X	X
Course structure	3.1.3.4 See Annex 10, Volume I, Attachment C, Note to 2.1.3	4.3.29 to 4.3.33	DDM	Outer limit of coverage to Point A: 30 µA all categories Point A to Point B: Cat I: Linear decrease to 15 µA Cat II: Linear decrease to 5 µA Cat III: Linear decrease to 5 µA Beyond Point B: Cat I: 15 µA to Point C Cat II: 5 µA to Reference datum Cat III: 5 µA to Point D, then linear increase to 10 µA at Point E. See Note 4 for application of tolerances.	See Annex 10, Volume I, Att. C, 2.1.5. From Point A to B, 3 µA decreasing to 1 µA From Point B to E, 1 µA	X	X	X
Coverage	3.1.3.3 See Annex 10, Volume I, Attachment C, Figures C-7 and C-8	4.3.34 to 4.3.36				X	X	X
Usable distance			Flag current, DDM	From the localizer antenna to distances of: 46.3 km (25 NM) within ±10° from the course line. 31.5 km (17 NM) between 10° and 35° from the course line. 18.5 km (10 NM) beyond ±35° if coverage is provided. (See detailed procedure for exceptions.)				
Field strength			Field strength	>40 microvolts/meter (-114 dBW/m^2)	±3 dB			

Table III - Flight inspection requirements and tolerances for localizer Category (Cat) I, II and III

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance	Uncertainty	Inspection type		
						S	C, C	P
Polarization	3.1.3.2.2	4.3.37	DDM	For a roll attitude of 20° from the horizontal: Cat I: 15 µA on the course line Cat II: 8 µA on the course line Cat III: 5 µA within a sector bounded by 20 µA either side of the course line.	± 1 µA	X	X	
Back course		4.3.41 to 4.3.43	DDM, Angle	Not less than 3°.	0.1 °		X	X
Sector width	N/A		DDM, Angle	Not less than 3°.	0.1 °			
Alignment	N/A		DDM, Distance	Within 60 m of the extended centre line at 1 NM.	±6 m			
Structure	N/A		DDM	Limit of coverage to final approach fix: ±40 µA FAF to 1.85 km (1 NM) from threshold: ±40 µA Decreasing at a linear rate to: ±20 µA	Annex 10, Volume I, Attachment C, 2.1.4			
Modulation depth	N/A		Modulation depth	18% to 22% approximately 9 km (5 NM) from the localizer. See Note 1.	±0.5%			
Monitor system	3.1.3.11	4.3.38		See Note 2.				
Alignment			DDM, Distance	Monitor must alarm for a shift in the main course line from the runway center line equivalent to or more than the following distances at the ILS reference datum. Cat I: 10.5 m (35 ft) Cat II: 7.5 m (25 ft) Cat III: 6.0 m (20 ft)	2 m 1 m 0.7 m		X	X
Displacement sensitivity			DDM, Distance	Monitor must alarm for a change in displacement sensitivity to a value differing from the nominal value by more than: Cat I: 17% Cat II: 17% Cat III: 17%	±4% ±4% ±2%		X	X

Table III - Flight inspection requirements and tolerances for localizer Category (Cat) I, II and III

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance	Uncertainty	Inspection type		
						S	C, C	P
Off-course clearance	3.1.3.11	4.3.38	DDM	Required only for certain types of localizer. Monitor must alarm when the off-course clearance cross-pointer deflection falls below 150 µA anywhere in the off-course coverage area.	±5 µA ±1 dB relative		X	X
Power			Power field strength	Monitor must alarm either for a power reduction of 3 dB, or when the coverage falls below the requirement for the facility, whichever is the smaller change. For two-frequency localizers, the monitor must alarm for a change of ±1 dB in either carrier, unless tests have proved that use of the wider limits above will not cause unacceptable signal degradation (>150 µA in clearance sector)	± 5 µA		X	

Notes:

1. Recommended means of measurement is by ground check.

2. Recommended means of measurement is by ground check, provided that correlation has been established between ground and air measurements.

3. Optional, at the request of the ground technician, unless good correlation between airborne and ground phasing techniques has not been established.

4. Course structure along the runway may be measured by flight inspection or by ground vehicle. Refer to ICAO DOC 8071 Volume I chapter 4 para 4.3.79 for guidance on structure analysis.

Legend: N/A = Not applicable
S = Site
C, C = Commissioning, Categorization
P = Periodic - Nominal periodicity 180 days

Table IV - Flight inspection requirements and tolerances for glide path Category (Cat) I, II and III

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance	Uncertainty	Inspection type		
						S	C, C	P
Angle		4.3.45, 4.3.46						X
Alignment	3.1.5.1.2.2		DDM, Angle	Cat I: Within 7.5% of nominal angle Cat II: Within 7.5% of nominal angle Cat III: Within 4% of nominal angle	Cat I: 0.75% Cat II: 0.75% Cat III: 0.3% of nominal angle	X	X	X
Height of reference datum	3.1.5.1.5 3.1.5.1.6 3.1.5.1.4		DDM	Cat I: 15 m (50 ft) + 3 m (10 ft) (See Note 3) Cat II: 15 m (50 ft) + 3 m (10 ft) (See Note 3) Cat III: 15 m (50 ft) + 3 m (10 ft) (See Note 3)	0.6 m		X	
Displacement sensitivity Value Symmetry	3.1.5.6	4.3.47 to 4.3.49	DDM, Angle	Refer to Annex 10, Volume I, 3.1.5.6	Cat I: 2.5% Cat II: 2.0% Cat III: 1.5%	X	X	X
Clearance		4.3.50	DDM, Angle		±6 µA for a nominal 190 µA Input 0.6 m	X	X	X
Below path	3.1.5.6.5			Not less than 190 µA at an angle above the horizontal of not less than 0.3θ. If 190 µA is realized at an angle greater than 0.45θ, a minimum of 190 µA must be maintained at least down to 0.45θ.				
Above path	3.1.5.3.1			Must attain at least 150 µA and not fall below 150 µA until 1.75θ is reached.				
Glide path structure	3.1.5.4	4.3.52	DDM	See Note 5. Cat I: From coverage limit to Point C: 30 µA. Cat II and III: From coverage limit to Point A: 30 µa From Point A to Point B: linear decrease from 30 µA to 20 µA. From Point B to reference datum: 20 µA.	Cat I: 3 µA Cat II: 2 µA Cat III: 2 µA	X	X	X
Modulation			Modulation depth	See Note 1.		X	X	X
Balance		4.3.53		0.002 DDM	0.001 DDM			
Depth	3.1.5.5.1	4.3.54		37.5% to 42.5% for each tone.	0.5%			

Table IV - Flight inspection requirements and tolerances for glide path Category (Cat) I, II and III

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance	Uncertainty	Inspection type		
						S	C, C	P
Obstruction Clearance		4.3.55	DDM	Safe clearance at 180 µA (Normal), or at 150 µA (wide alarm).	Subjective assessment	X	X	X
Coverage	3.1.5.3	4.3.56				X	X	X
Usable distance			Flag current,	Satisfactory receiver operation in sector 8° azimuth either side of the localizer center line for at least 18.5 km (10 NM) up to 1.75θ and down to 0.45θ above the horizontal, or to a lower angle, down to 0.3θ as required to safeguard the glide path intercept procedure.	±3 dB			
Field strength			Field strength	>400 µV/m (-95 dBW/m^2) (Refer to Annex 10 for specific signal strength requirements.)				
Monitor system	3.1.5.7	4.3.57, 4.3.58		See Note 2.				
Angle			DDM, Angle	Monitor must alarm for a change in angle of 7.5% of the promulgated angle	±4 µA		X	X
Displacement sensitivity			DDM, Angle	Cat I: Monitor must alarm for a change in the angle between the glide path and the line below the glide path at which 75 µA is obtained, by more than 0.037θ. Cat II: Monitor must alarm for a change in displacement sensitivity by more than 25%. Cat III: Monitor must alarm for a change in displacement sensitivity by more than 25%.	±4 µA ±1 dB		X	X

Table IV - Flight inspection requirements and tolerances for glide path Category (Cat) I, II and III

Parameter	Annex 10 Volume I Reference	Doc 8071 Volume I Reference	Measured	Tolerance	Uncertainty	Inspection type		
						S	C, C	P
Power			Power	Monitor must alarm either for a power reduction of 3 dB, or when the coverage falls below the requirement for the facility, whichever is the smaller change. For two-frequency glide paths, the monitor must alarm for a change of ±1 dB in either carrier, unless tests have proved that use of the wider limits above will not cause unacceptable signal degradation.	±0.5 dB		X	X
Phasing		4.3.59 to 4.3.65		No fixed tolerance. To be optimized for the site and equipment. See Note 4.	N/A		X	X

Notes:

1. Recommended means of measurement is by ground check.

2. Recommended means of measurement is by ground check, provided that correlation has been established between ground and air measurements.

3. This requirement only arises during commissioning and categorization checks. The method of calculating the height of the extended glide path at the threshold is described in ICAO DOC 8071 Volume I chapter 4 para 4.3.81, Analysis C Reference datum height (RDH). For Category I approaches on Code 1 and 2 runways, refer to 3.1.5.1.6 of Annex 10, Volume I.

4. Optional, at the request of the ground technician.

5. Tolerances are referenced to the mean course path between Points A and B, and relative to the mean curved path below Point B.

Legend: N/A = Not applicable
S = Site
C, C = Commissioning, Categorization
P = Periodic - Nominal periodicity 180 days

4.3.5. General

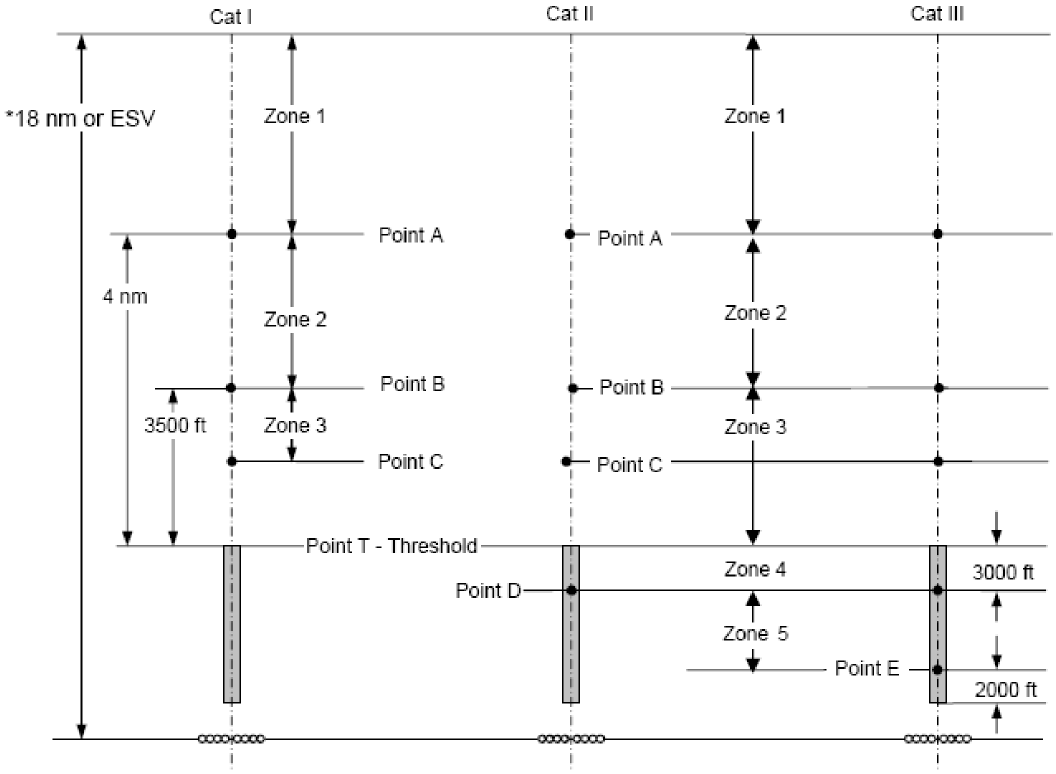
4.3.5.1 All ILS flight inspections shall be made by an organization having CAAI approval for ILS inspection

4.3.5.2 The procedures for conducting the flight inspection of the parameters listed in Tables III & IV are intended to provide basic instruction for positioning the aircraft for proper measurement, analysis of performance data and application of tolerances. These procedures should not be construed as the only means of accomplishing the intended purpose.

4.3.5.3 Some requirements in the procedures can be fulfilled concurrently with others, thereby amplifying the conduct of the flight inspection. These procedures assume that the deviation indicator current, flag alarm current and AGC will be recorded, and that the recorder event marks will be made as required for analysis.

4.3.5.4 During inspections, certain parameters require the use of aircraft positioning or tracking devices to provide accurate aircraft position relative to the localizer course or glide path for adequate analysis of the performance.

4.3.6. ILS ZONES AND POINTS



* 25 nm for ICAO

ILS Point "A"	An imaginary point on the glidepath/localizer *on-course* measured along the runway centerline extended, in the approach direction, 4 nautical miles from the runway threshold.
ILS Point "B"	An imaginary point on the glidepath/localizer on-course measured along the runway centerline extended, in the approach direction, 3,500 ft. from the runway threshold.
ILS Point "C"	A point through which the downward extended straight portion of the glidepath (at the commissioned angle) passes at a height of 100 ft. above the horizontal plane containing the runway threshold.
ILS Point "D"	A point 12 ft. above the runway centerline and 3,000 ft. from the runway threshold in the direction of the localizer.

ILS Point "E"	A point 12 ft. above the runway centerline and 2,000 ft. from the stop end of the runway in the direction of the runway threshold.
ILS Point "T"	A point at specified height located vertically above the intersection of the runway centerline and the *runway threshold* through which the *downward extended straight line* portion of the ILS glidepath passes.
ILS Zone 1	The distance from the coverage limit of the localizer/glidepath to Point "A" (four miles from the *runway threshold).*
ILS Zone 2	The distance from Point "A" to Point "B"
ILS Zone 3	CAT I - The distance from Point "B" to Point "C" for evaluations of Category I ILS. CAT II and III - The distance from Point "B" to the *runway threshold* for evaluations of Category II and III facilities.
ILS Zone 4	The distance from runway threshold to Point "D".
ILS Zone 5	The distance from Point "D" to Point "E".
ILS Reference Datum	Same as ILS Point "T".

4.3.7. Localizer front course

4.3.7.1 Identification

The coded identification that is transmitted from the facility should be monitored during the various checks over all of the coverage area. The identification is satisfactory if the coded characters are correct, clear and properly spaced. The transmission of the identification signal should not interfere in any way with the basic localizer function. Monitoring the identification also serves the purpose of detecting frequency interference, which is primarily manifested by heterodyne, or noise which affects the identification.

4.3.7.2 Voice feature

Where the facility has the capability of ground to-air voice transmission on the localizer frequency, it will be checked over all of the coverage area in generally the same way as the identification. It should be checked to ensure that it adequately serves its purpose as a ground-to-air communication channel and does not adversely affect the course.

4.3.7.3 Modulation

4.3.7.3.1. Modulation balance.

Although the modulation balance is most easily measured on the ground, it may be measured from the air while radiating the carrier signal only. Position the aircraft close to the runway center line and note the cross-pointer indication.

4.3.7.3.2. Modulation depth.

The percentage of modulation should be determined only while flying in-bound and on course at a point where the receiver signal strength corresponds to the value at which the receive modulation depth calibration was made; therefore, this requirement should be fulfilled concurrently with the alignment check. If the receiver modulation depth indications are influenced significantly by the RF level, measure the modulation depth near Point A. (An adequate preliminary check of modulation can be made while the aircraft is crossing the course during the displacement sensitivity check.) Modulation percentage is determined by the use of calibration data furnished with the individual receiver.

4.3.7.4 Displacement sensitivity

4.3.7.4.1. There are two basic methods of measuring the displacement sensitivity — approaches on the edges of the course sector, and crossovers or orbits through the course sector, at right angles to the extended runway center line. For site tests and commissionings, the approach method is recommended. For all flight inspections the correlation between ground and air measurement should not exceed 10 per cent of the promulgated displacement sensitivity; where this degree of correlation is not achieved, the reason for the discrepancy should be resolved. On initial categorization, the displacement sensitivity should be set to the nominal value for that installation.

4.3.7.4.2. To determine the half-sector width in degrees using the approach method, fly the aircraft on either side of the course line so that the average cross-pointer deflection is 75 (or 150) microamperes in each instance. Note that deviation of the aircraft toward the runway extended center line will reduce the accuracy of the measurements — normally the average cross-pointer deflection should be within 15 (or 30) microamperes of the intended value. The average angular position of the aircraft, measured by the tracking device on each side of the course line, will define the angular value of the half-sector width. If the displacement sensitivity corresponding to the measured half-sector width is beyond the tolerances, the displacement sensitivity should be readjusted.

4.3.7.4.3. The crossover or orbital method of displacement sensitivity measurement is typically used during periodic inspections.

4.3.7.4.4. The measurement is made at a point of known distance from the localizer antenna; a distance of 11 km (6 NM) from the localizer, or the outer marker, is usually convenient for this purpose. To best calculate the displacement sensitivity, it is necessary to use several samples from the linear DDM area and find the slope of the straight line that fits the data. In order to provide an accurate reference for subsequent use, and to correlate the results with the half-sector width measurement, this abbreviated procedure should initially be carried out during the commissioning or major inspection.

4.3.7.4.5. Experience has shown that the results of subsequent routine checks using the orbital method will show good correlation with the measurements obtained during the initial tests. It may be possible to combine this abbreviated procedure with orbits flown for other measurement purposes.

4.3.7.4.6. The following is an example of measuring course displacement sensitivity by this method. Fly a track at right angles to the localizer course line so as to pass directly over the outer marker, or selected checkpoint, at a height of 460 m (1500 ft.) above the localizer antenna site elevation. The flight should begin sufficiently off course to assure stable airspeed prior to penetration of the course sector. Follow the aircraft position with the tracking device and measure the angles at which 150, 75, 0, 75 and 150 μA occur. The full sector from 150 to 150 μA should be flown so that linearity can be assessed by examining the recordings.

4.3.7.5 Off-course clearance

4.3.7.5.1. The localizer clearance is checked to determine that the transmitted signals will provide the user with the proper off-course indication and that there are no false courses. Conduct an orbital flight with a radius of 9 to 15 km (5 to 8 NM) from the facility and approximately 460 m (1500 ft.) above the antenna. Where terrain is a factor, the height will be adjusted to provide line-of-sight between the aircraft and the antenna.

4.3.7.5.2. Clearance should be checked only to the angular limits of coverage provided on either side of the front course (typically ±35 degrees), unless the back course is used for approaches. In such cases, clearances will also be checked to the angular coverage limits of the back course. An annual 360-degree orbit is recommended in order to check for possible false courses in the out-of-coverage area. These false courses may be due to antenna pattern characteristics or environmental conditions, and may be valuable in establishing the historical behavior of the facility.

4.3.7.6 High angle clearance

4.3.7.6.1. The combination of ground environment and antenna height can cause nulls, or false courses, which may not be apparent at all normal instrument approach altitudes. High altitude clearance should therefore be investigated upon:

a) Initial commissioning;
b) A change in the location of an antenna;
c) A change in the height of an antenna; or
d) Installation of a different type antenna.

4.3.7.6.2. Normally, high-angle clearance is investigated within the angular limit of coverage provided, in the same manner as for off-course clearance, at a height corresponding to an angle of 7 degrees above the horizontal through the antenna. If the minimum clearance at this height, in an orbit of 9 to 15 km (5 to 8 NM), exceeds 150 microamperes, and the clearance is satisfactory at 300 m (1000 ft.), the localizer will be assumed as satisfactory at all intermediate altitudes. Where the clearance is not satisfactory, additional checks will be made at lower heights to determine the highest level at and below that which the facility may be used. In such a case, procedural use of the localizer should be restricted.

4.3.7.6.3. If approach altitudes higher than the height of 1800 m (6000 ft.) above the antenna elevation are required locally, investigation should also be made at higher heights to determine that adequate clearance is available and that no operationally significant false courses exist.

4.3.7.7 Course alignment accuracy

4.3.7.7.1. The measurement and analysis of localizer course alignment should take into account the course line bends. The alignment of the mean course line needs to be established in the following critical region before the appropriate decision height:

Category I — in the vicinity of ILS Point B
Category II — ILS Point B to ILS reference datum
Category III — ILS Point C to ILS Point D

4.3.7.7.2. A normal ILS approach should be flown, using the glide path, where available. The aircraft's position should be recorded using the tracking or position fixing system. By relating the aircraft average position to the average measured DDM, the alignment of the localizer may be determined.

4.3.7.7.3. Where there are course line bends in the area being evaluated, they should be analyzed so that the average localizer alignment may be calculated.

4.3.7.8 Course structure

4.3.7.8.1. This is an accurate measurement of course bends and may be accomplished concurrently with the alignment and displacement sensitivity checks. Recordings of approaches made during the course alignment check and during the course sensitivity checks can be used for the calculation of course bends. The center, or mean, of the total amplitude of bends represents the course line for bend evaluation purposes, and the tolerance for bends is applied to that as a reference. If the evaluation is made on airborne data, low pass filtering of the position-corrected cross-pointer signal is necessary to eliminate high-frequency structure components of no practical consequence. The total time-constant of the receiver and recorder DDM circuits for the measurements should be referenced to an aircraft speed of 105 knots, for which the constant is approximately 0.5 second (refer to Attachment C to Annex 10, Volume I, 2.1.7, for specific filter guidance).

4.3.7.8.2. From the recording of airborne measurements, the alignment for each zone for application of structure tolerances may be determined as the average course position between the runway threshold and Point D, and separately between Point D and Point E. To analyze the post-filtering low frequency spectral components, the guidance found in Attachment C to Annex 10, Volume I, 2.1.4 and 2.1.6, should be used, with the structure tolerances referenced to the average course position in each zone.

4.3.7.8.3. For the evaluation of a course center line structure, a normal approach should be flown, using the glide path, where available. For Category II and III localizers, the aircraft should cross the threshold at approximately the normal design height of the glide path and continue downward to the normal touchdown point. Continue a touchdown roll until at least Point E. Optionally, the touchdown roll may be conducted from touchdown to Point D, at which point a take-off may be executed, with an altitude not exceeding 15 m (50 ft.) until Point E is reached. These procedures should be used to evaluate the localizer guidance in the user’s environment. Accurate tracking or position fixing should be provided from ILS Point A to the following points:

For Category I — ILS reference datum
For Category II — ILS reference datum
For Category III — ILS Point E

4.3.7.8.4. If the localizer’s back course is used for take-off guidance, bend measurements along the runway should be made for any category of ILS.

4.3.7.8.5. Guidance material concerning course structure is provided in 2.1.4 to 2.1.7 of Attachment C to Annex 10, Volume I.

Note - Course structure should be measured only while the course sector is in its normal operating width.

4.3.7.9 Coverage

4.3.7.9.1. This check is conducted to determine whether the facility provides the correct information to the user throughout the area of operational use. Coverage has been determined, to some extent, by various other checks; however, additional procedures are necessary to complete the check of the coverage at distances of 18.5, 31.5 and 46.3 km (10, 17 and 25 NM) from the antenna.

4.3.7.9.2. Flights at appropriate heights are required for routine and commissioning inspections to ensure the following coverage requirements are satisfied. Adequate coverage for modern aircraft systems may be defined by a signal level of 5 microvolts (from a calibrated antenna installation) at the receiver input together with 240 microamperes of flag current. If the ground installation is required to support aircraft fitted with receivers having a sensitivity poorer than 5 microvolts, a higher signal input (up to 15 microvolts) should be used when assessing coverage for these aircraft. The localizer coverage sector extends from the localizer antenna to distances of:

46.3 km (25 NM) within ±10° from the front course line;
31.5 km (17 NM) between 10° and 35° from the front course line;
18.5 km (10 NM) outside of ±35°, if coverage is provided.

Where topographical features dictate or operational requirements permit, the limits may be reduced to 33.3 km (18 NM) within the ±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 should be receivable at the distances specified at and above a height of 600 m (2000 ft.) above the elevation of the threshold or 300 m (1000 ft.) above the elevation of the highest point within the intermediate and final approach areas, whichever is the higher.

4.3.7.9.3. At periodic inspections, it is necessary to check coverage only at 31.5 km (17 NM) and 35 degrees either side of the course, unless use is made of the localizer outside of this area.

4.3.7.10 Polarization

4.3.7.10.1. This check is conducted to determine the effects of undesired vertically polarized signal components. While maintaining the desired track (on the extended centre line), bank the aircraft around its longitudinal axis 20 degrees each way from level flight. The aircraft's position should be monitored using an accurate tracking or position fixing system. Analyze the cross-pointer recording to determine if there are any course deviations caused by the change in aircraft (antenna) orientation. The effects of vertically polarized signal components are acceptable when they are within specified tolerances. If this check is accomplished in the area of the outer marker, the possibility of errors due to position changes will be lessened. The amount of polarization effect measured also depends on polarization characteristics of the aircraft antenna, hence the vertical polarization effect of the aircraft antenna should be as low as possible.

4.3.7.11 Localizer monitors

Localizer course alignment and displacement sensitivity monitors may be checked by ground or flight inspection. A suggested method of flight inspection is given below:

a) Alignment monitor.

Position the aircraft on the exact center line of the runway threshold and ensure that the aircraft voltages are satisfactory and that adequate localizer signals are received. To ensure that excessive course displacement will cause an alarm, request the ground technician to adjust the localizer equipment to cause an alarm of the alignment monitor. The precise displacement in microamperes may be taken from the recording in each condition of the alarm to the right and left of the center line and converted mathematically to meters (feet). The computation for conversion of the microampere displacement at the threshold into distance should consider the actual (measured) displacement sensitivity. After the course has been readjusted to a normal operating condition, its alignment should be confirmed.

b) Displacement sensitivity monitor.

Request the maintenance technician to adjust the displacement sensitivity to the broad and narrow alarm limits and check the displacement sensitivity in each condition. This check should follow the normal displacement sensitivity check described in 4.3.7.4.1 to 4.3.7.4.6. The crossover or orbital flight method should be used only if good correlation with a more accurate approach method has been established. After the alarm limits have been verified or adjusted, it is also necessary to confirm the displacement sensitivity value in the normal operating condition.

Note - During commissioning inspection or after major modifications, clearance may be checked while the displacement sensitivity is adjusted to its broad alarm limit. The tolerances of 175 microamperes and 150 microamperes specified for application during normal displacement sensitivity conditions will then be reduced to 160 microamperes and 135 microamperes, respectively.

c) Power monitors (commissioning only).

The field strength of the localizer signal should be measured on course at the greatest distance at which it is expected to be used, but not less than 33.3 km (18 NM), while operating at 50 per cent of normal power. If the field strength is less than 5 microvolts, the power will be increased to provide at least 5 microvolts and the monitor limit adjusted to alarm at this level.

Note - Fifteen microvolts may be required - see 4.3.7.9.2.

4.3.7.12 Phasing

4.3.7.12.1. The following phasing procedure applies to null reference localizer systems. Alternative phasing procedures in accordance with the manufacturer’s recommendations should be followed for other types of localizers. To the extent possible, methods involving ground test procedures should be used, and airborne measurements made only upon request from ground maintenance personnel. If additional confirmation is desirable by means of a flight check, the following is a suitable example procedure:

Note - Adjustments made during the phasing procedure may affect many of the radiated parameters. For this reason, it is advisable to confirm the localizer phasing as early as possible during the commissioning tests.

a) Measure the displacement sensitivity of the localizer if it is not already determined.

b) Feed the localizer antenna with the carrier equally modulated by 90 Hz and 150 Hz and load the sideband output with a dummy load. Note the cross-pointer deflection as X(90) or X(150) microamperes.

c) The aircraft should be flown at a suitable off-course angle (depending on the type of localizer antenna used) during the phasing adjustment and should not be closer than 5.6 km (3 NM) from the antenna.

d) Insert a 90-degree line in a series with the sideband input to the antenna and feed the antenna with sideband energy.

e) Adjust the phaser until the deviation indicator reading is the same as in b) above.

f) Remove the 90-degree line, used in step d) above.

4.3.7.12.2. This completes the process of phasing the carrier with the composite sidebands. As an additional check, displacement sensitivity should be rechecked, and compared with that obtained in step a) above. The value obtained after the phasing adjustment should never be greater than the value obtained before the phasing adjustment.

4.3.7.13 Localizer back course

4.3.7.13.1. The back course formed by some types of localizers can serve a very useful purpose as an approach aid, provided that it meets specified requirements and that an associated aid is available to provide a final approach fix. Although a glide path is not to be used in conjunction with the back course, landing weather minima commensurate with those of other non-precision aids can be approved. The display in the aircraft cockpit will present a reverse sensing indication to the pilot; however, pilots are well aware of this and it is not considered significant.

4.3.7.13.2. Under no circumstances should localizer equipment be adjusted to enhance performance of the back course, if the adjustment would adversely affect the desired characteristics of the front course.

4.3.7.13.3. Where the localizer back course is to be used for approaches to landing, it should be evaluated for commissioning and at periodic intervals thereafter. Procedures used for checking the front course will normally be used for the back course, the principal difference being the application of certain different tolerances, which are given in Table III. As a minimum, alignment, sector width, structure, and modulation depth should be inspected

4.3.8. Glide path

Most glide path parameters can be tested with two basic flight procedures — an approach along the course line, and a level run or orbit through the localizer course sector. Variations include approaches above, below, or abeam the course line, and level runs left and right of the extended runway center line. By selecting suitable starting distances and angles, several measurements can be made during a single aircraft manoeuver.

4.3.8.1 Glide path angle (site, commissioning, categorization and periodic)

4.3.8.1.1. The glide path angle may be measured concurrently with the glide path structure during these inspections. To adequately check the glide path angle, an accurate tracking or positioning device should be employed. This is necessary in order to correct the recorded glide path for aircraft positioning errors in the vertical plane. The location of the tracking or positioning equipment with respect to the facility being inspected is critical for accurate measurement. Incorrect siting can lead to unusual characteristics being shown in the glide path structure measurements. The tracking device should initially be located using the results of an accurate ground survey. In certain cases, initial flight results may indicate a need to modify the location of the tracking device. The arithmetic mean of all deviations of this corrected glide path between ILS Point A and ILS Point B represented by a straight line will be the glide path angle, as well as the average path to which tolerances for glide path angle alignment and structure will be applied. Because of the normal flare characteristics of the glide path, the portion below ILS Point B is not used in the above calculation.

4.3.8.1.2. At commissioning, the glide path angle should be adjusted to be as near as possible to the desired nominal angle. During periodic inspections, the glide path angle must be within the figures given in Table IV.

4.3.8.2 Displacement sensitivity (site, commissioning, categorization and periodic)

The mean displacement sensitivity is derived from measurements made between ILS Point A and Point B. Make approaches above and below the nominal glide path at angles where the nominal cross-pointer deflection is 75 μA and measure the aircraft’s position using an accurate tracking device. During these measurements, the average cross-pointer deflection should be 75 ±15 μA. Note that any aircraft deviation toward the zero DDM course line will decrease the accuracy of the measurement. The displacement sensitivity can be calculated by relating the average cross-pointer deflection to the average measured angle.

4.3.8.3 Glide path angle and displacement sensitivity (routine periodic inspections)

4.3.8.3.1. During certain periodic inspections it may be possible to measure the glide path angle and displacement sensitivity by using a level run or “slice” method. This is only possible where the glide path is relatively free from bends so that there is a smooth transition from fly-up to fly-down on the level run. This method should not be used with systems that inherently have asymmetrical displacement sensitivity above and below the glide path.

4.3.8.3.2. Level run method.

Fly the aircraft towards the facility at a constant height (typically the intercept altitude), following the localizer center line, starting at a point where the cross-pointer deflection is more than 75 µA fly-up (more than 190 µA recommended). This flight is usually made at 460 m (1 500 ft.) above the facility unless terrain prevents a safe flight. If a different height is used, it should be noted on the flight inspection report and facility data sheet. During the flight, the aircraft’s angular position should be constantly tracked. By relating the recorded cross-pointer current to the measured angles, the glide path angle and displacement sensitivity may be calculated. The exact method of correlating the angle and cross-pointer measurements is dependent on the particular flight inspection system.

4.3.8.4 Clearance

4.3.8.4.1. The clearance of the glide path sector is determined from a level run, or slice, through the complete sector during which the glide path transition through the sector is recorded. This measurement may be combined with the level flight method of measuring the glide path angle and displacement sensitivity.

4.3.8.4.2. This flight is made using the level run method, except that the run should commence at a distance corresponding to 0.3θ and should continue until a point equivalent to twice the glide path angle has been passed. The aircraft’s position should be accurately measured throughout the approach. Cross-pointer current should be continuously recorded and the recording marked with all the necessary distances and angles to allow the figures required in Table IV to be evaluated. This recording should also permit linearity of the cross-pointer transition to be evaluated.

4.3.8.5 Glide path structure

Glide path structure is an accurate measurement of the bends and perturbations on the glide path. It is most important to employ an accurate tracking or positioning device for this measurement. This measurement may be made concurrently with the glide path angle measurement. Guidance material concerning course structure evaluation is provided in 2.1.5 of Attachment C to Annex 10, Volume I.

4.3.8.6 Modulation

4.3.8.6.1. Modulation balance.

The modulation balance is measured while radiating the carrier signal only. Position the aircraft close to the glide path angle and note the cross-pointer indication.

4.3.8.6.2. Modulation depth.

This check can be best accomplished accurately while the aircraft is “on-path”; therefore, final measurements are best obtained during angle checks. The measurements should be made at a point where the receiver input corresponds to the value at which the receiver modulation depth calibration was made. If the receiver modulation depth indications are influenced significantly by the RF level, measure the modulation depth near Point A. For measurement systems that do not provide separate modulation level outputs, preliminary indications of modulation can be obtained during level runs at the time the aircraft crosses the glide path. The depth of modulation (in per cent) can be obtained by comparing the glide path receiver flag-alarm-current to the receiver-flag-current-calibration data.

4.3.8.7 Obstruction clearance

Checks may be made beneath the glide path sector to assure a safe flight path area between the bottom edge of the glide path and any obstructions. To accomplish this check, it is necessary to bias the pilot’s indicator or use an expanded scale instrument. Position the aircraft on the localizer front course inbound at approximately five miles from the glide path antenna at an elevation to obtain at least 180 µA “fly-up” indication. Proceed inbound maintaining at least 180 µA clearance until the runway threshold is reached or it is necessary to alter the flight path to clear obstructions. This check will be conducted during monitor checks when the path width is adjusted to the wide alarm limits during which a minimum of 150 µA fly-up is used in lieu of 180 µA. When this check has been made during broad path width monitor limit checks, it need not be accomplished after the path is returned to the normal width of the normal approach envelope, except during the commissioning inspection.

4.3.8.8 Glide path coverage

This check may be combined with the clearance check using the same flight profile. If a separate flight is made, it is not necessary to continue the approach beyond the intercept with the glide path lower width angle. At site, commissioning, categorization and periodic checks this measurement should be made along the edges of a sector 8° either side of the localizer center line. Coverage will normally be checked to a distance of 18.5 km (10 NM) from the antenna. Coverage will be checked to a distance greater than 18.5 km (10 NM) to the extent that it is required to support procedural use of the glide path.

4.3.8.9 Monitors

Where required, monitor checks may be made using identical measurement methods to those described for glide path angle, displacement sensitivity and clearance. The level flight method for angle and displacement sensitivity should not be used if there is non-linearity in the areas being evaluated.

4.3.8.9.1. Power monitor (commissioning only).

The field strength of the glide path signal should be checked at the limits of its designated coverage volume, with the power reduced to the alarm level. Alternatively, if the monitor alarm limit has been accurately measured by ground inspection, the field strength may be measured under normal operating conditions and the field strength at the alarm limit may be calculated. This check may be made at the same time as clearance and coverage checks.

4.3.8.9.2. Phasing and associated engineering support tests

- The glide path site test is made to determine whether the proposed site will provide satisfactory glide path performance at the required path angle. It is extremely important that the site tests be conducted accurately and completely to avoid resiting costs and unnecessary installation delays. Because this is functionally a site-proving test rather than an inspection of equipment performance, only one transmitter is required.
- A preliminary glide path inspection is performed upon completion of the permanent transmitter and antenna installation, but prior to permanent installation of the monitor system. This inspection is conducted on one transmitter as a preliminary confirmation of airborne characteristics of the permanent installation. Additionally, it provides the installation engineer with data that enables the engineer to complete the facility adjustment to the optimum for the commissioning inspection. This requires the establishment of transmitter settings for monitor alarm limits. These settings will be utilized by

ground personnel to determine that the field monitor is installed at its optimum location and that integral monitors are correctly adjusted to achieve the most satisfactory overall monitor response.

- The procedures for conducting various glide path engineering support tests are described below. Normally, these checks will be performed by ground methods prior to the flight inspection, and airborne checks will be conducted at the option of the ground technician. It is not intended that they will supplant ground measurements, but that they will confirm and support ground tests. The details of these tests will be included in the flight inspection report.

4.3.8.9.3. Modulation balance.

Although the modulation balance is most easily measured on the ground, it may be measured from the air while radiating the carrier signal only. Fly a simulated “on-path” approach recording the glide path indications. The average deviation of the glide path indication from “on-path” should be noted for use in the phasing check. Ground personnel should be advised of the result. The optimum condition is a perfect balance, i.e. zero on the precision micro ammeter. If the unbalance is 5 μA or more, corrective action should be taken by ground personnel before continuing this test.

Note.- Level runs are not satisfactory for this test since shifting of centering may occur in low-signal or null areas.

4.3.8.9.4. Phasing — transmitting antennas.

The purpose of the phasing test is to determine that optimum phase exists between the radiating antennas. There are several different methods of achieving airborne phasing and these tests should normally be made using the manufacturer’s recommended methods. Where difficulty is experienced in achieving airborne phasing to a definite reading by normal procedures, the flight inspector should coordinate with the ground engineer to determine the most advantageous area for conducting the phasing test.
When this area and track are determined, it should be noted on the facility data record for use on future phasing tests of that facility.

4.3.8.9.5. Phasing — monitor system.

Some types of glide path integral monitor need flight inspection checks to prove that they will accurately reproduce the far-field conditions when changes occur in transmitted signal phases. Procedures for making such checks should be developed in conjunction with the manufacturer's recommendations.

4.3.8.9.6. Glide path antenna adjustment (null checks).

These checks are conducted to determine the vertical angles at which the RF nulls of the various glide path antennas may occur. The information is used by ground staff to assist them in determining the correct heights for the transmitting antennas. The test is made with carrier signals radiating only from each antenna in turn. The procedure for conducting this test is by level flight along the localizer course line. The angles of the nulls will be computed in the same manner as the glide path angle is computed. The nulls are characterized by a sharp fall in signal level.

4.3.9. Calibration

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

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

4.3.9.3 Calibration intervals shall be stated in the calibration records. Evidence shall be available to support the quoted calibration intervals

4.3.10. Analysis of Flight Inspection Records

4.3.10.1 The ATS Provider shall analyses the flight inspection report at the earliest opportunity for operational systems and prior to entering a facility into operational service, to ensure that the flight inspection requirements are met.

4.3.10.2 The ATS Provider shall address any deficiencies or non-compliance to ensure a safe service is provided.

4.3.10.3 An ATS Provider may delegate the task of analyzing the flight inspection report to a third party specialist organization. This may be the flight inspection organization that provided the report.

4.3.10.4 The responsibility for addressing any deficiencies identified remains with the ATS Provider.

4.3.10.5 The person who conducts the analysis shall be competent to do so.

Note: This may include training on a specific flight inspection report format

4.3.11. Report

4.3.11.1 When measurements show that the interference level exceeds limits, the appropriate CAAI inspector must be advised immediately.

4.3.11.2 Evidence of the required routine measurements must be available when requested by a CAAI inspector.

4.4. Summary of testing requirements

4.4.1. Summary of testing requirements — Localizer

Parameter	Annex 10, Volume I, reference	Testing
Voice feature	3.1.3.8	F
Modulation balance and depth	3.1.3.5	F/G
Displacement sensitivity	3.1.3.7	F/G
Off-course clearance	3.1.3.7.4	F
High-angle clearance	N/A	F
Course alignment accuracy	3.1.3.6	F/G
Course structure	3.1.3.4	F/G
Coverage (usable distance)	3.1.3.3	F/G
Polarization	3.1.3.2.2	F
Monitor system	3.1.3.11	F/G
Phasing	N/A	F/G
Orientation	3.1.3.1	G
Frequency	3.1.3.2	G
Spurious modulation	3.1.3.2.3	G
Carrier modulation frequency	3.1.3.5.3	G
Carrier modulation harmonic content 90 Hz	3.1.3.5.3 d)	G
Carrier modulation harmonic content 150 Hz	3.1.3.5.3 e)	G
Unwanted modulation	3.1.3.5.3.2	G
Phase of modulation tones	3.1.3.5.3.3	G

Parameter	Annex 10, Volume I, reference	Testing
Phase of modulation tones dual frequency systems	3.1.3.5.3.4	G
Phasing of alternative systems	3.1.3.5.3.5	G
Sum of modulation depths	3.1.3.5.3.6	F/G
Sum of modulation depths when utilizing radiotelephony communications	3.1.3.5.3.7	F/G
Frequency and phase modulation	3.1.3.5.4	G
DDM increase linear	3.1.3.7.4	F
Phase to avoid null on dual frequency systems	3.1.3.8.3.1	F/G
Peak modulation depth	3.1.3.8.3.2	G
Audio frequency characteristic	3.1.3.8.3.3	G
Identification — no interference with guidance information	3.1.3.9.1	F
Identification tone frequency	3.1.3.9.2	G
Identification modulation depth	3.1.3.9.2 G	G
Identification speed	3.1.3.9.4	G
Identification repetition rate	3.1.3.9.4	G
Monitoring — total time of out-of-tolerance radiation	3.1.3.11.3	G
Back course sector width	N/A	F
Back course alignment	N/A	F
Back course structure	N/A	F
Back course modulation depth	N/A	F

Legend: N/A = Not applicable
F = Flight inspection
G= Ground test

4.4.2. Summary of testing requirements — Glide Path

Parameter	Annex 10, Volume I, reference	Testing
Angle		
Alignment	3.1.5.1.2.2, 3.1.5.1.4	F/G
Height of reference datum	3.1.5.1.5, 3.1.5.1.6	F/G
Displacement sensitivity	3.1.5.6	F/G
Clearance below and above path	3.1.5.3.1, 3.1.5.6.5	F/G
Glide path structure	3.1.5.4	F
Structure	N/A	F
Modulation balance and depth	3.1.5.5.1	F/G
Obstruction clearance	N/A	F
Coverage (usable distance)	3.1.5.3	F/G
Monitor system	3.1.5.7	F/G
Phasing	N/A	F/G
Orientation	3.1.5.1.1	G
Frequency	3.1.5.2.1	G
Polarization	3.1.5.2.2	F
Unwanted modulation	3.1.5.2.3	G
Carrier modulation frequency	3.1.5.5.2 a), b) and c)	G
Carrier modulation harmonic content 90 Hz	3.1.5.5.2 d)	G
Carrier modulation harmonic content 150 Hz	3.1.5.5.2 e)	G
Unwanted amplitude modulation	3.1.5.5.2.2	G
Phase of modulation tones	3.1.5.5.3	G
Phase of modulation tones, dual frequency systems	3.1.5.5.3.1	G
Phase of modulation tones, alternative systems	3.1.5.5.3.2	G
Monitoring — total time of out of tolerance radiation	3.1.5.7.3.1	G

Legend: N/A = Not applicable
F = Flight inspection
G= Ground test

4.5. **Maintenance of ILS Navigation Radio Stations**

4.5.1. General Requirements

4.5.1.1 Maintenance arrangements shall be established to ensure the continued availability and reliability of all ILS Navigation Radio Stations, associated with the provision of an ATC service.

4.5.1.2 In addition to the requirements below, ILS Navigation Radio Stations systems maintenance shall comply with ICAO Doc 8071 Volume I – Testing of Ground-Based Radio Navigation System

4.5.1.3 All the technicians will be properly trained on the ILS Navigation Radio Stations.

4.5.1.4 A record of any functional test, flight checks and particulars of any maintenance, repair, overhaul, replacement or modification shall be kept in respect of the equipment and systems at ILS Navigation Radio Stations, as or a period of two years.

4.5.1.5 Provision is made in the certificates for a record of an individual's proficiency. This may be used to record how often an individual performs maintenance duties on specific equipment and/or lapses in competency on specific equipment.

4.5.2. Training

4.5.2.1 A training program ensuring that the employees shall execute their positions and the activities laid upon them in an appropriate professional level according to the service provider procedures;

4.5.2.2 The training will be according to ICAO Doc 9712.

4.5.2.3 The training program will be accepted by the CAAI.

4.5.2.4 The training program shall include separate parts according to these details:

4.5.2.4.1. Initial training;

4.5.2.4.2. Periodic training;

4.5.2.4.3. Special training;

4.5.2.4.4. Human factor training;

4.5.2.4.5. Work safety;

4.5.3. Maintenance program

4.5.3.1 A maintenance program is the source of scheduled inspections, relevant controls and supporting data. The Maintenance Program should always be active (subject to review and amendment) and utilized such as to enable effective maintenance to be carried out in a logical, concise, clear and controllable manner.

4.5.3.2 The CAAI approval of the Maintenance Program provides a mechanism to record minimum standards that the service provider must comply with.

4.5.3.3 The maintenance program may be applicable to more than one ILS Navigation Radio Stations of the same type.

4.5.3.4 The inspector will review the maintenance program according to applicable supporting information provided by the service provider.

4.5.3.5 The maintenance program will be design to meet Human Factors principles.

4.5.3.6 Consideration should be given to routinely monitoring equipment at adverse weather conditions (i.e. salt laden atmosphere, high humidity, extreme heat etc). These considerations should include increasing maintenance inputs for cleaning, lubrication and inspection of protective finishes as an example.

4.5.3.7 The maintenance program should include:

4.5.3.7.1. Preface that include the following:

- The type/model of the equipment and, where applicable, power systems.
- A list of the manuals (reference, revision numbers) that were used to prepare the maintenance manual (supporting information).
- A statement signed by the service provider accountable manager that:
    - The specified equipment will be maintained according to the maintenance program; and
    - The program will be reviewed and updated as required; and
    - Practices and procedures to satisfy the maintenance program will be to the standards specified in the manufacture Maintenance Instructions. In the case of approved practices and procedures that differ, the statement should refer to them.

4.5.3.7.2. List of scheduled inspections that include for each task the following information:

- Task description
- Interval
- Reference to manufacturer manual or other supporting information.
- Skill of technician – if required.

- Applicability – if the maintenance program is used for more than one facility.
- List of items with life limitation (including the life limitation for each item).

4.5.3.7.3. Forms

- All the forms/log books that are going to be used will be part of the maintenance program.

4.5.3.7.4. Additional procedures if required.

4.5.3.7.5. Permitted variations to maintenance periods (Due Date window).

4.6. Additional information

The inspector will review all the other documents required by CAAI AP 1.7.005 / 2.7.005 (ATS equipment installation, maintenance, operation & approval).

4.7. Demonstration and Inspection Phase

4.7.1. CAAI requires service providers to demonstrate their ability to comply with regulations and safe operating practices before issuing approval to the ATS equipment.

4.7.2. These demonstrations include actual performance of activities and/or operations while being observed by the inspector.

4.7.3. The demonstration will include:

4.7.3.1 Compliance checklist of ground test requirements to ICAO annex 10 volume I and ICAO doc 8071 Volume I, including all the supporting documents (if applicable):

4.7.3.1.1. Manufacture compliance check list to ICAO documents.
4.7.3.1.2. Compliance for the specific Model and S/N
4.7.3.1.3. Factory Acceptance Test (FAT)
4.7.3.1.4. Customer Acceptance Test (CAT)
4.7.3.1.5. Site Acceptance Test (SAT)
4.7.3.1.6. Any other document that supporting the compliance.

4.7.3.2 Compliance checklist of flight test requirements to ICAO annex 10 volume I and ICAO doc 8071 Volume I, including all the supporting documents

4.7.3.3 Compliance checklist of maintenance program requirements to ICAO annex 10 volume I and ICAO doc 8071 Volume I

4.7.4. The demonstration will include on-site evaluations of equipment maintenance and support facilities.

4.7.5. During these demonstrations and inspections, the inspector will evaluate the effectiveness of the policies, methods, procedures, and instructions as described in the Service provider manuals and other documents.

4.7.6. Deficiencies will be brought to the attention of the service provider and corrective action must be taken before an approval is issued.

5. Task Outcomes

5.1. After the document compliance and the demonstration and inspection phases have been completed satisfactorily, the inspector will prepare the Aeronautical Telecommunication Service Certificate that include all the information (equipment model, frequencies, identification, location, limitations etc..).

5.2. The service provider must acknowledge receipt of these documents.

5.3. The process above should be documented in the Sharedocs system.