NIGERIAN CIVIL AVIATION AUTHORITY

Advisory Circular

NCAA- AC-ANS(AET) 009

30th August 2018.

ADVISORY CIRCULAR ON FLIGHT INSPECTION AND CALIBRATION OF NAVIGATION AND LANDING AIDS

Approval.

This Advisory Circular is approved by the Director General, Nigerian Civil Aviation Authority (NCAA) and published on the NCAA website: www.ncaa.gov.ng.

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Date 31 – 10 – 2018

PREFACE

This Advisory Circular is a reference document on Flight Inspections and calibration of navigation and landing aids. It provides policy, procedures, information and guidance on how the Service Provider can implement the requirements in the relevant parts of Nigeria Civil Aviation Regulations.

This is the first edition of the advisory circular on flight inspection and Calibration of navigation and landing aids. The document describes inspection types and facilities subject to flight inspections and their periodicity of inspection as **acceptable** means of compliance with the requirements of Nig. CARs 14.7.24-14.7.25. It further describes flight Inspection preparations, planning, co-ordination, notification of flight inspection status and presentation of flight inspection and calibration report. It details the requirements for authorization of flight Inspection Organization, crew members, airborne and ground support equipment requirements.

TABLE OF CONTENT

CONTENT	PAGE
Approval Page	1
Preface	2
Table of Content	3
Record of Revision	4
List of Effective Pages	5
Intentionally left Blank	6
Purpose of the Advisory Circular	7
Applicability of the Advisory Circular	7
References	7
Definition of Terms	8
Pre- Flight Inspection Preparations	9
Coordination during Flight Inspections	10
Types of Flight Inspections	10 - 11
Authorization for Flight Inspection Organization	11 - 12
Preparation of Flight Inspection Plan	13
Flight Inspection and calibration Periodicity	14
Flight Inspection Documentation	15
Table 1: Very High Frequency (VHF) Omni-direction Radio Range (VOR) Flight Inspection Requirements	16
Table 2: Distance Measuring Equipment (DME) Flight Inspection Requirements	17-19
Table 3: Instrument Landing System (ILS) Flight Inspection Requirements	20 – 25
Table 4: Lighting system flight Inspection Requirements	26
Notification of Flight Inspection Status	27
Post-Flight Inspection Reports and Measures	28
Intentionally left blank	29
Appendix A	30
Appendix B	31
Appendix C	32
Appendix D	33-34
Appendix E	35
Appendix F	36
Appendix G	37

RECORD OF REVISIONS

Issue Number/Amendment Number	Page(s) Affected	Date Entered	Entered By	Signature
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LIST OF EFFECTIVE PAGES

Chapter	Page	Effective Date
APPROVAL PAGE	1 of 37	30th August, 2018
PREFACE	2 of 37	30th August, 2018
TABLE OF CONTENT	3 of 37	30th August, 2018
RECORD OF REVISION	4 of 37	30th August, 2018
LIST OF EFFECTIVE PAGES	5 of 37	30th August, 2018
INTENTIONALLY LEFT BLANK	6 of 37	30th August, 2018
PURPOSE OF ADVISORY CIRCULAR	7 of 37	30th August, 2018
REFERENCES	7 of 37	30th August, 2018
DEFINITION OF TERMS	8 of 37	30th August, 2018
PRE-FLIGHT INSPECTION PREPARATION	9 of 37	30th August, 2018
COORDINATION DURING FLIGHT INSPECTIONS	9-10 of 37	30th August, 2018
TYPE OF FLIGHT INSPECTIONS	10 of 37	30th August, 2018
AUTHORIZATION FOR FLIGHT INSPECTION ORGANIZATION	11 -12 of 37	30th August, 2018
PREPARATION OF FLIGHT INSPECTION PLAN	13 of 37	30th August, 2018
FLIGHT INSPECTION AND CALIBRATION PERIODICITY	14 of 37	30th August, 2018
FLIGHT INSPECTION DOCUMENTATION	15 of 37	30th August, 2018
TABLE 1: VERY HIGH FREQUENCY (VHF) OMNI-DIRECTION RADIO RANGE (VOR) FLIGHT INSPECTION REQUIREMENTS	16 of 37	30th August, 2018
TABLE 2: DISTANCE MEASURING EQUIPMENT (DME) FLIGHT INSPECTION REQUIREMENTS	17 – 19 of 37	30th August, 2018
TABLE 3: INSTRUMENT LANDING SYSTEM (ILS) FLIGHT INSPECTION REQUIREMENTS	20-21 of 37	30th August, 2018
GUIDANCE	22-25 of 37	30th August, 2018
TABLE 4: LIGHTING SYSTEM FLIGHT INSPECTION REQUIREMENTS	26 of 37	30th August, 2018
NOTIFICATION OF FLIGHT INSPECTION STATUS	27 of 37	30th August, 2018
POST-FLIGHT INSPECTION REPORTS AND MEASURES	28 of 37	30th August, 2018
INTENTIONALLY LEFT BLANK	29 of 37	30th August, 2018
APPENDIX A	30 of 37	30th August, 2018
APPENDIX B	31 of 37	30th August, 2018
APPENDIX C	32 of 37	30th August, 2018
APPENDIX D	33 – 34 of 37	30th August, 2018
APPENDIX E	35 of 37	30th August, 2018
APPENDIX F	36 of 37	30th August, 2018
APPENDIX G	37 of 37	30th August, 2018

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1.0 PURPOSE

1.1 *This Advisory Circular (AC) is intended to provide general guidance on* flight inspection and calibration of radio navigation and landing aids, including inspection types and facilities subject to flight inspections and their periodicity of inspection as *acceptable means of compliance with the requirements of Nig.CARs 14.7.24-14.7.25*

1.2 Applicability.

1.2 Applicability.

This Advisory Circular is applicable to Air Navigation service provider required to provide Aeronautical Telecommunication Services (Communication, navigation and Surveillance) under the Nigerian Civil Aviation Regulations part 14.7.24 and 14.7.25

1.3 Cancellation.

This is the first official version of this Advisory Circular and therefore cancels no other Advisory Circulars on flight inspection and calibration of radio navigation and landing aids.

2.0 REFERENCES

2.0 Civil Aviation Act 2006 Sections 30:2(g) and 30 .3(k)

2.1 Nig. CARs 14.7.24-14.7.25

2.2 ICAO Doc 8071

2.3. Aerotels Manual of Standards Part I,

2.4 Aerotels Checklist CL: AC-)

2.5 ICAO Annex10Vol.1

2.6 NCAA-AC-ANS(AET)- 004

3.0 DEFINITIONS OF TERMS

Concerned Service Provider(s) is (are) advised to refer to Nig.CARs 14.7.24-14.7.25 and Aerotels Manual of Standards part I (3.2) for detailed definition of terms used in the advisory circular and specifically those related to navigation and landing aids.

3.1 **Flight Inspection** –Is a quality assurance program which verifies that the performance of air navigation facilities and associated instrument flight procedures conform to prescribed standards throughout their publish service volumes, (it is series of flight test conducted to establish the operational classification of a facility). An activity comprising flight testing or flight check (i.e., measurement of aeronautical facility characteristics in an airborne environment). Flight inspection comprises reviewing flight procedures (such as routes, arrival and departure) to ensure navigational support is sufficient, there are no obstacles, and the procedure is reliable. Flight Inspection are required to examine the signals-in-space as received at the aircraft after being influenced by external factors such as site conditions, ground conductivity, terrain, irregularities, metallic structure, propagation effects, etc.

3.1.2 **Purpose of Flight Inspection and Calibration: -** Flight Inspection program is to measure signal- in-space, provide correlated ground and air-borne data at commissioning on a periodic basis and determine system performance based on a traceable measurement standard. Flight inspection data is useful in determining facility deterioration and the necessity for facility upgrading to improve performance. It also enhance surveillance, monitoring and certification of navigational/ associated facilities and airspace systems in the most efficient, economic and effective manner for the safety of air traffic management and aircraft operations in the proficient and profitability to close air traffic loop.

3.1.3 **Activities During Flight Inspection**

3.1.3.1 Typical correlation activity begins with a confirmation that airborne and ground test equipment are running within tolerances- achieved by comparing ground and flight tests generator and receiver.

3.1.2.2 Where tolerances are not met, the flight inspection must be delayed until the cause of the problem is eliminated or aborted depending on the complexity of the problem to enable ground maintenance engineers to conduct the necessary repair and ground check. If the ground or airborne results are one of discrepancy tolerances during flight inspection and the cause(s) cannot be determined, then the ground monitor clearance limits should be tightened, the facility declassified appropriately, downgraded, or removed from service.

3.1.2.3 The successful completion of the flight inspection (all tolerances are met) establishes that the ground maintenance activities are effective and the interval between inspections may be maintained at the optimum periodicity.

3.2 Flight Inspection/Calibration Periodicity

This is the minimum frequency of periodic flight inspections to ascertain the facility operational life-time-circle continuous availability, reliability and accuracy of data in space to ensure minima deterioration, above which facility signal-in-space will no longer be accurate and useable, for flight procedures (such as routes, arrival and departure) for efficient, navigational support.

4.0 Pre- Flight Inspection Preparations

4.1. The Air Navigation Service Provider (ANSP) shall forward to the Authority annual flight inspection /calibration status of all the navigation and landing aids and at least a two-year plan of implementation of flight inspection periodicity latest 31st December of every year. (See appendix A).

4.1.1. The ANSP shall conduct the ground check of navigation and landing aids at least two weeks prior to the date of flight inspection.

4.1.1.2 The ANSP shall provide evidence of status of the air-borne equipment of the calibration aircraft to the Authority.

4.1.2 The Air traffic Safety Electronics Personnel Safety / Maintenance Engineers shall make necessary preparations prior to a flight inspection to ensure that the flight inspection is efficiently conducted.

4.1.3 The following are the points to be observed during preflight inspection preparation:

i) Ensure that the result of all possible ground calibration and checking equipment are correct.

ii) Availability of last flight inspection report.

iii) Any requirement of special investigation during flight inspection shall be submitted in advance to the Authority for observation during flight inspection.

iv) In a situation where the facility is not expected to be ready as per the regular flight inspection periodicity, the Authority shall be advised accordingly and appropriate NOTAM issued without delay.

v) NOTAM for withdrawal of facility during Flight Inspection shall be issued without fail in coordination with local ATC.

vi) Availability of dedicated transport for equipment and personnel is ensured during the entire course of flight check.

vii) Ensure all special tools and instruments are available at the site.

viii) Air traffic Safety Electronics Engineering Personnel / Maintenance Engineers are available to make corrections and adjustments on ground during flight inspection exercise

4.2 Coordination during Flight Inspections

4.2.1 Air traffic Safety Electronics Engineering Personnel / Maintenance Engineers shall be available to make corrections and adjustments on ground during flight inspection exercise.

4.2.2 In-Flight Inspection

During the inspection, flight inspector shall advise ATSEP/Engineer of observed conditions which require adjustments of ground equipment. Request for adjustment shall be specific and readily understandable. Normally the flight inspector is not expected to diagnose the fault, but shall furnish sufficient information to enable the maintenance team on ground (ATSEP) make the corrective adjustment when the aircraft is airborne and record the adjustments done for post analysis. Relevant measurements on ground for establishing a meaningful correlation with the flight check results after each run shall be taken.

4.3 Types of Flight Inspections

4.3.1 Flight inspections are classified as follows:

i) **Site approval:** Inspection to be carried out to confirm that the location selected for installation of a new air navigation aid is appropriate. This may include checks normally made during a commissioning inspection and any additional tests which may be required.

ii) **Commissioning:** This is a comprehensive inspection to be carried out to obtain complete information regarding all aspects of performance of navigational aids. The facility shall not be declared operational before this check.

iii) **Periodic:** Inspection to be conducted on a regular basis to confirm the validity of air navigation aids.

iv)**Surveillance:** Surveillance inspection shall be conducted by the Flight Inspection to ensure that Navigational aids facility spot checks of individual components observed during normal flight operations are maintained within tolerance limits in spite of the inherent drift in the equipment. Surveillance inspections do not normally involve major adjustments unless the performance is observed to have out-of-tolerance or unsatisfactory. Condition found on a surveillance inspection shall require a report to the appropriate authorities and if necessary initiate a NOTAM.

v) **Special Inspections:** Special flight inspection shall be made if there is need to confirm satisfactory performance. It may be due to replacement of a component (e.g. Antenna system) and comprehensive maintenance on the equipment. Restoration of established facilities unscheduled outages as well as investigation of reported malfunctions.
Special Flight Inspection may also be carried out for investigation purposes and after an incident or accident.

4.4 Authorization for Flight Inspection Organization

4.4.1 Flight inspection of air navigation shall be conducted by organizations or department that is statutory assigned the responsibility approved by the Authority.

4.5 Flight Inspection Aircraft

4.5.1 This section describes the concept for the special requirements of the aircraft, flight inspection crew members and ground support equipment used for flight Inspection.

4.5.2. Appropriately equipped aircraft shall be used when required to undertake flight inspection. The general characteristics of a flight inspection aircraft shall be as follows:

a) Aircraft equipped with special instrument for flight check
b) Sufficient range and endurance for a normal mission.
c) Aerodynamically stable throughout the speed range.
d) Low noise and vibration level
e) Adequate and stable electrical system capable of operating required electronic and recording equipment and other aircraft equipment.
f) Wide speed and altitude range to allow the conduct of flight inspections under normal conditions as encountered by the users.

4.5.3 Recording Equipment. The flight inspection system must include equipment that electronically records the measured parameters of the navigational aid being inspected Recorded data must be marked to correlate with the aircraft's position at the time of the measurement.

4.5.4 Laboratory Equipment Calibration. All measuring equipment used for flight inspection must be calibrated to defined standards.

(a) Regular calibration of the flight inspection receivers and position fixing system, as well as ground equipment used to maintain and calibrate them, must be performed traceable to the National Institute of Standards and Technology. The calibration may be performed either onboard the flight inspection aircraft or in a laboratory. Calibration intervals must be included in the calibration records and be made available for inspection.

(b) Clearly defined calibration procedures must be maintained and used for all equipment involved in flight inspection measurements.

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

4.5.5 Build State and Modification Control.

The Build State of all equipment, including test equipment, must be recorded and the records updated whenever modifications or changes are made. All modifications must be accurately documented and cross-referenced to modification labels or numbers on the equipment. After making any modification, tests and analysis must ensure that the modification fulfills its intended purpose and that it has no undesired side effects.

4.5.6 Flight Inspection Software. All software (i.e. procedures, formulas, algorithms, etc.) used in flight inspection measurements and in trajectory control of the aircraft during flight inspection maneuvers must meet high safety and quality assurance standards. (It is assumed that all avionics used for these purposes have been certified to airworthiness standards.)

4.5.7 Flight Inspection Crew Members

The members of the flight inspection crew shall be experts in their individual fields, have sound knowledge and experience in flight inspection procedures and be capable of working as a team.

4.5.8 Airborne and Ground Support Equipment

The selection and utilization of flight inspection equipment used to determine the validity of navigation information shall minimize the uncertainty of the measurement being performed. Aircraft and ground support flight inspection equipment shall be calibrated to appropriate standards.

5.0 Preparation of Flight Inspection Plan

5.1 ANSP shall prepare the following year flight inspection plan for all air navigation aids and notify the Authority (section 4.1).

5.1.1 When it is necessary to change the flight inspection date, the ANSP shall notify the Authority of the change.

5.2 Flight Inspections Priority

5.2.1 ANSP shall conduct flight inspections according to the following priorities:

a) Inspection requested from a concerned agency in relation to an aircraft accident or incident.

b) Inspection to correct a malfunction of an air navigation aid, inspection of a reported malfunction, or inspection after repairs according to a plan.

c) Periodic, Commissioning, site approval or inspection of instrument flight procedures.

5.2.2 Inspection after upgrading or modification of facility

Inspection shall be carried out when the conditions below prevail:

a) Upgrade/modification of major components (feeders, antennas e.t.c)

b) Change in location of antenna or upgrade/modification of VOR counter poise;

c) Modification or replacement of main components of the transmitter;

d) Change in operation frequency and/or ID code;

e) Change in transmission output following increase or decrease of an air navigation aid's service area;

f) Where there is concern for signal interruption from construction of a building, a power line, or other obstacles in the vicinity of an operating air navigation aid;

5.2.3 Flight Inspection and calibration Periodicity

5.2.3.1 Nig.CARs 14.7.24 and **14.7.25, Aerotels MOS Part 1 section 3.2.1** prescribe the frequency of periodic flight inspections. More frequent inspections may be made when deemed necessary. Facilities subject to flight inspections and periodicity of their inspections are as follows

NAVAIDS Facility	Maximum Periodicity, Ground Check	Maximum Periodicity, Flight Inspection
DVOR	12 months	36 months
CVOR	12 months	12 months
ILS	3months	6 Months
DME	6 months	6 Months
NDB	6months	12 months where operationally required
Airfield/Approach Lighting system and PAPIs		12 months

5.2.3.2 The ANSP shall issue a NOTAM on Navigation and Landing Aids which are not calibrated at the expiry of periodicity.

****NOTE-** Reliability and stability depends on age, design, technology, and operational environment. Stability is affected by excessive maintenance, adjustments, attributable to either human error or variations in test equipment.
Ground maintenance activity and its frequency is dependable on maintenance, design, reliability, and stability of test equipment.

6.0 Flight Inspection Documentation:

(1) Documentation of flight inspection results must comply with Flight Inspection Report Processing System (FIRPS).

(2) Records and graphs of flight measurements must meet the following requirements:

(a) System parameters must be retrievable. Clear and concise system parameters must be recorded on all records and graphs and be easily retrievable. Scaling of parameters must be appropriate to the required uncertainty requirements. The data comprising these recordings and graphs must be stored with sufficient accuracy that expanded scale plots can be provided on demand.

(b) When parameters are evaluated by comparison of the received signal and the output of a tracking device, only the final result need be presented for a normal inspection. However, position data and raw signal data must be recorded or stored and provided on demand, for cases where further analysis is required.

(c) Each record and graph must be identified with the aircraft tail number, the date and flight description, and the facility being inspected.

(3) Flight inspection documentation, including reports, records, graphs, and any other relevant data, must be retained in equipment shelter and copies forwarded to the Nigerian Civil Aviation Authority. The following tables depict facilities parameters which must be measurable to accuracies.

Table 1

6.1 Very High Frequency (VHF) Omni-direction Radio Range (VOR) Flight Inspection Requirements

1. PURPOSE. This table lists the minimum measurement requirements for VOR facilities

2. MEASUREMENTS. VOR parameters must be measurable to the accuracy shown in the table below

Parameter	Measured	Tolerance	Maximum Uncertainty
Azimuth Accuracy Alignment Bends Roughness & Scalloping	Deviation	± 2.5° ± 3.5° ± 3.0°	0.6° 0.6° 0.3°
Coverage	Field Strength	90 µV/m	3 dB absolute[1] 1 dB repeatability
Modulation	Modulation Depth	25 to 35%	1%
Bearing Monitor	Deviation	± 1.0°	0.3°

Note: Sensing/ Rotation and Monitors

3. GUIDANCE. The power level into the receiver is used as the normal reference parameter for the determination of field strength. The power level into the receiver can be converted to absolute field strength if the antenna factor and cable losses are known

Table 2

6.2 DISTANCE MEASURING EQUIPMENT (DME) FLIGHT INSPECTION REQUIREMENTS

1. PURPOSE. This appendix lists the minimum measurement requirements for DME facilities.

2. MEASUREMENTS. DME parameters must be measurable to the accuracy shown in the table below.

Parameter	Measured	Tolerance	Maximum Uncertainty
Range Accuracy	Distance	<150 m <75m if DME associated with landing aids	20 m
Coverage	Field Density	-89 dBw/m^2	3 dB absolute[1] 1 dB repeatability

3. GUIDANCE:

a. The following equipment is needed for DME:

(1) A DME interrogator or, if possible two. Having a second interrogator in the aircraft provides standby equipment and makes it possible to compare the information given by the two interrogators in case of difficulties. The interrogators should have outputs making it possible to:

(a) Measure and record digital output with distance, and AGC voltage, from which the signal strength at the receiver input may be deduced. (Signal level errors of the order of 3 dB may be expected from the interrogator receiver and this should be considered when evaluating data from this source)

(b) Make observations on an oscilloscope of the video signal before and after decoding; the suppression pulses, indicating that the transmitter is operating; and the coding signals of the interrogator, a particularly useful observation in case of anomalies during flight inspection.

(c) Observe reply pulses synchronized with interrogation pulses to detect the possibility of false lock-on by lesser quality receivers

b. The following calibration guidance applies to DME flight inspection equipment:

(1) Interrogator Pulse Repetition Rate. The pulse transmission should be repeated at a rate of 30 pair per second, 5% of the time spent in the SEARCH mode and 95% in the TRACK mode. The variation in time between successive pairs should be sufficient to prevent false lock-on.

(2) Frequency Stability. The center frequency of the radiated signal should not vary more than ± 100 kHz from the assigned frequency.

(3) Peak Power Output. The peak power output measured at the interrogator should be at least 100 watts. The constituent pulses of a pulse pair should have the same amplitude within 1 dB. Special care should be taken when using GPS reference systems with phase measurements and in particular when using the GPS L_2 frequency. This frequency is close to the DME band, and the maximum output power of the interrogator and the separation of the antennas should be kept in mind.

(4) Spurious Radiation. Spurious radiation between pulses on any DME interrogation or reply frequency measured in a receiver having the same characteristics of a DME transponder receiver should be more than 50 dB below the peak radiated power of the desired pulses. The spurious CW power radiated from the interrogator on any DME interrogation or reply frequency should not exceed 20 microwatts (- 47 dBW).

(5) Sensitivity. The signal level required at the input terminals to effect a successful end-of-search nine out of ten cycles should not exceed -82 dBm when the input signal is a DME test signal having 70% reply efficiency. The required signal level should not exceed -79 dBm when the test signal contains 6000 random pulses 10 dB above the test signal level. The minimum signal levels are -85 and -82 dBm respectively to maintain tracking under the above conditions.

(6) Selectivity. The level of the input signal required to produce a successful end-of-search nine out of ten cycles should not vary in excess of 6 dB over the band 120 kHz above and below the assigned reply frequency. This includes receiver frequency stability requirements. The level of the input signal required to produce an average of not more than one successful end-of-search out of ten cycles (and that one to track for not more than five seconds) should be at least 30 dB greater than the on-frequency signal described above, and nine out of ten successful end-of-search cycles when the off-frequency signal is displaced by 940 kHz either side of the assigned channel frequency. Over the frequency range of 960 MHz to 1,215 MHz, excluding frequencies within 1 MHz of the desired channel, the equipment should not respond to nor be adversely affected by an undesired frequency DME signal having a level 50 dB above the level of the signal on the desired channel.

NOTE 1: In operational use, an adjacent channel transponder would provide at least 80 dB rejection of adjacent channel interrogations. Since the transponder effectively prevents replies to adjacent channel interrogations, no lock-on can occur.

NOTE 2: Spurious Responses. Over the frequency range of 90 kHz to 10,000 MHz, excluding frequencies within 3 MHz of the desired channel, a CW signal having a level of -30 dBm should not adversely affect the receiver sensitivity.

(7) Decoder Selectivity. The equipment should be calibrated to indicate distance satisfactorily when the spacing of the received pulses is varied from 11.5 to 12.5 microseconds for X-channel or from 29.5 to 30.5 microseconds for Y-channel, over the input signal level range from -48 dBm to the minimum tracking level. If the spacing between pulses is less than 10 microseconds or more than 14 microseconds for X-channel, or less than 28 microseconds or more than 32 microseconds for Y-channel, and the signal level is below -48 dBm, that signal should not be decoded.

(8) Search Speed. Search speed should be at least 10 NM per second.

(9) Memory. To enable the detection of unlocks, the memory time of the equipment should be approximately 5 seconds upon the loss of signal. The information displayed during this period should be that information which was being displayed at the time of the loss of the signal ±1 mile.

(10) Calibration. The indication “Distance = 0 NM” should correspond to a time delay in responding to an interrogation of 50μs ± 1μs.

(11) Airborne Antenna. The radiation pattern should be as omnidirectional as possible in the horizontal plane. It should be sited in such a way as to be free from masking effects of the aircraft structure. The use of two antennas may be a good solution. The characteristics of the antenna and associated feeder line should be considered when interpreting the results of measurements.

Table 3

6.3 INSTRUMENT LANDING SYSTEM (ILS) FLIGHT INSPECTION REQUIREMENTS

1. PURPOSE. This appendix lists the minimum measurement requirements for ILS facilities.

2. MEASUREMENTS. ILS parameters, including those from systems intended to be electrically equivalent to ILS (e.g., Transponder Landing System) must be measurable to the accuracy shown in the tables below.

LOCALIZER SUBSYSTEM

Parameter	Measured	Tolerance	Maximum Uncertainty
Alignment	DDM	CAT I: 10.5m CAT II: 7.5m CAT III: 3.0m	2 m 1 m [2] 0.7 m [2]
Displacement Sensitivity	DDM	CAT I: Within 17% CAT II: Within 17% CAT III: Within 10%	3 μA 3 μA 2 μA
Off Course Clearance	DDM	Between 10 and 35°, 150 uA	5 μA with 150 μA input
Course Structure	DDM	CAT I: 15 uA CAT II: 5 uA CAT III: 5 uA	1 uA 1 uA 1 uA
Coverage	Field Density	-114 dBW/ m[1]	3 dB absolute[1] 1 dB repeatability
Modulation Balance Depth	DDM Modulation Depth	0.002 DDM 18-22%	0.01 DDM 0.5%
Monitor Alignment Displacement Sensitivity Off Course Clearance Power	DDM DDM DDM Field Strength	CAT I: 10.5m CAT II: 7.5m CAT III: 6.0m CAT I: Within 17% CAT II: Within 17% CAT III: Within 10% 150 μA 3 dB reduction	2 m 1 m 0.7 m 3 μA 3 μA 2 μA 5 μA with 150 μA input

			1 dB relative

GLIDE SLOPE SUBSYSTEM

Parameter	Measured	Tolerance	Maximum Uncertainty
Alignment	DDM, Angle	CAT I: within 7.5% CAT II: within 7.5% CAT III: within 4%	0.75%[1] 0.75%[1] 0.3%[2]
Displacement Sensitivity	DDM, Angle	.0875 DDM at: CAT I: ±(0.07-0.14) θ CAT II: ±0.12 θ CAT III: ±0.12 θ	0.02 θ 0.02 θ 0.02 θ
Off Course Clearance	DDM, Angle	190 μA at 0.3 θ	6 μA with 190 μA input
Course Structure	DDM	CAT I: 30μA CAT II: 20 μA CAT III: 20 μA	3 μA 2μA 2 μA
Coverage	Field Density	-95 dBW/ m^2	3 dB absolute[1] 1 dB repeatability
Modulation Balance Depth	DDM Modulation Depth	0.002 DDM 37.5-42.5 %	0.001 DDM 0.5 %[1]
Monitor Alignment Displacement Sensitivity Power	DDM, Angle DDM Field Strength	7.5% CAT I: 0.037 θ CAT II: 25 % CAT III: 25 % 3 dB reduction	4 uA 4 μA 4 μA 4 μA 1 dB relative

3. GUIDANCE. The following paragraphs define minimal performances of the equipment constituting the radio signals in flight measurement subsystem and recommends calibration procedures to reach them.

a. General:

(1) A flight-testing system may use equipment other than ILS receivers normally used for aircraft navigation (e.g., bench test equipment or portable ground maintenance receivers). Care should be used to ensure that this equipment performs the same as conventional, high-quality aircraft equipment.

(2) For convenience reasons, the assessment of the accuracy of the reception and processing equipment of the radio subsystem will be made in units suitable to parameters to be measured -- in microamperes. To ensure a simple equivalence between the different units in which tolerances are expressed, the following relations are used: 1μA = 0.01° for a distance of 4,000 m (13,000 feet) between localizer antenna and the threshold, and 1μA = 0.005° for a glide path angle of 3°.

(3) The evaluation of parameters such as course alignment and displacement sensitivity is performed by the radio electrical and positioning subsystems. These measurements are polluted by the specific errors of these two subsystems. By nature, these errors are independent, and it is allowable to consider that the global statistical error on the parameter to be measured is equal to the root square of the sum of the squares of the equally weighted errors of the two parts of the system.

b. Equipment:

(1) To minimize the errors due to implementation, antennas should be installed according to recommendations listed in Chapter 1. As an example of this importance, note that when the aircraft is over the runway threshold, a vertical displacement of 6 cm (2.5 inches) is equal to approximately 0.01° in elevation angle, observed from the glide path tracking site.

(2) The receivers used should measure at a minimum the DDM, SDM, signal input level, and modulations depths. For integrity and technical comfort, the simultaneous use of two receivers is strongly recommended. This redundancy offers a protection against errors that might occur during the flight inspection because of unexpected short-term changes in a receiver's performance. A divergence of their output signals can therefore be noted immediately.

(3) Equipment constituting the acquisition and processing subsystem should have such performance that it does not degrade the acquired parameters. It is necessary that signal acquisition occurs synchronously with the positioning determination of the plane, to compare measurements that correspond in time. It will be possible to convert, by the use of calibration tables, the radio electrical signals into usual physical units with a convenient resolution, and to consider the actual functioning of the receiver in its operational environment. The graphic display and record should be such that they will allow the flight Inspector to evaluate fluctuations of signals against the required tolerances.

c. Calibration:

(1) In the case where receivers deliver electrical voltages characterizing signals to be measured, calibration tables are first necessary to provide changes of units. Some equipment delivers the flight inspection parameters directly in the desired units, and calibration tables converting the different voltages into suitable units are not required in this case. Nevertheless, it is necessary to correct some errors of the subsystem (receiver centering error for instance), and limited calibration procedures will be accordingly defined. It is necessary to establish enough calibration tables that those established for a given frequency may be transposable to nearby ILS frequencies without significant error.

(2) In most cases, the tables to be developed are described below:

Localizer: For a given VHF frequency:
(a) V_{agc} = f (input level), input level varying from: -104 dBm to -18 dBm
I_{dev} = f (input level), input level varying from: -90 dBm to -18 dBm
and for: DDM = 0
DDM = 0.155 in the 90 Hz
DDM = 0.155 in the 150 Hz

(b) I_{flag} = f (input level), input level varying from: -90 dBm to -18 dBm and for modulation depths varying from: 17% to 23%

(c) V_{90Hz} and V_{150Hz} = f (modulation depth), for different values of the modulation depths, their sum remaining constant, and at different values of input level

Glide path: For a given UHF frequency:
(a) V_{agc} = f (input level), input level varying from: -104 dBm to -18 dBm
I_{dev} = f (input level), input level varying from: -90 dBm to -18 dBm
and for: DDM = 0

DDM = 0.088 in the 90 Hz
DDM = 0.088 in the 150 Hz

(b) I_{flag} = f (input level), input level varying from: -90 dBm to -–18 dBm and for modulation depths varying from: 34% to 46%

(c) V_{90Hz} and V_{150Hz} = f (modulation depth), for different values of the modulation depths, their sum remaining constant, and at different values of injection.

d. Positioning System. The evaluation of some parameters includes a combination of errors coming from the radio electrical outputs and from the positioning subsystem. By nature, these errors are independent, and it is acceptable to consider that the global statistical error on the parameter to be measured is equal to the square root of the sum of the squares of the equally weighted errors of the two parts of the system.

e. Accuracies. The required accuracies are calculated by converting tolerances on the different ILS parameters into degrees, using the following formulas:

(1) Loc alignment tolerance = ± (tolerance in µA x nominal sector width/ 150) degrees

(2) GP alignment tolerance = θ ± (tolerance in µA x nominal sector width/ 150) degrees

(3) Loc or GP sector tolerance = nominal sector x [150/ (150 ± tolerance in µA)] degrees

f. Error Budget. The different components of the error budget relative to the positioning measurement of the plane are listed below:

(i) The uncertainty on the database describing geometrically the field and the facility to be inspected (definition of every characteristic point in the runway reference coordinates system)

(ii) The uncertainty on the platform coordinates (x, y, z) on which the positioning system is set up.

(iii) The lack of care in setting up the positioning system on the ground.
(iv) The instrumentation error within its operating limits defined by the manufacturer.

(v) Atmospheric refraction if optical or infrared tracker is used.

(vi) Parallax error due to the fact that the positioning system and the phase center of the facility to be measured are not co-located.

(vii) Error due to the fact that the reference aircraft positioning point and the localizer or glide path antenna are not co-located.

(viii) Conical effect of the radiated pattern of the glide path in the final part of the approach

To reduce the three last components above, it is necessary to use high accuracy devices providing distance (to a few meters), heading and attitude (to about 0.1° each) information. If distance, heading, and attitude parameters are not available, a crosswind limit should be set which allows measurement accuracies to be within the limits required

Table 4
6.4 AIR FIELD LIGHTING SYSTEM
FLIGHT INSPECTION REQUIREMENTS

1. PURPOSE. This appendix lists the minimum measurement requirements for lighting systems.

2. MEASUREMENTS. Lighting system parameters must be measurable to the accuracy shown in the table below.

Parameter	Measured	Tolerance	Maximum Uncertainty
Visual glidepath angle	Elevation degrees	± 0.2 °	0.05 °[1]
Coverage	Azimuth, degrees from approach angle	> ± 10 °	0.5 °

3. GUIDANCE:

a. Although it is not necessary to use a special aircraft for the flight testing of lighting systems, it is highly desirable that the aircraft used be specially designated for this work.

b. If a special aircraft is not used, a theodolite suitably modified to read accurately the displacement in azimuth and elevation of the flight test aircraft from the desired approach path may be required.

7.0 Notification of Flight Inspection Status

7.1.1 The ANSP shall determine operational levels of air navigation aids based on the results of flight inspections, notify the Authority and published in AIP.

7.1.2 *Usable:* This is a status assigned to air navigation aids that are deemed to be operational in a flight inspection and shall be assigned one of the following operational status:

i) *Unrestricted*: Assigned in cases where signals-in-space can be generated within the air navigation aid's coverage area to maintain safety and continuity of the air navigation aid and precise signals can be sent.

ii) *Limited or Restricted*: Assigned in cases where there are spaces that cannot send normal signals in all or some sections within the coverage area of the air navigation aid. In such cases, limited/restricted use of navigation aid can be assigned in sections where there are no impediments in use of the navigation aid in question by an aircraft. However, limited/restricted status shall not be assigned when judged that it is difficult to secure safety and continuity of the air navigation aid for instance where one of the transmitters is unserviceable.

7.1.3 *Unusable*: This is assigned in cases where it is judged that the air navigation aid cannot be used due to difficulty in securing safety and continuity of the navigation aid within its operational range or in cases where there are airspaces wherein flight inspections cannot be conducted because of signal failure, designation as a no-fly zone, or airspace use is restricted for other reasons.

7.2 Notification of Status Levels of Air Navigation Facilities

7.2. 1 When it is deemed necessary to newly assign or change the status level of an air navigation aids following results of a flight inspection, ground ATSEP shall notify the relevant agencies for status to be published in the AIP. When it is deemed that an immediate action is needed, the following shall be observed: -

a) For an air navigation aid assigned unrestricted, restricted or usable, a request shall be made to the Authority so that notification of the assignment or change in operational status can be made immediately in the NOTAM.
b) For an air navigation aid assigned unusable status, action shall be taken by the ANSP to immediately suspend operation of the air navigation aid and appropriate NOTAM issued.

7.3 Post-Flight Inspection Reports and Measures

7.3.1 The flight inspector shall determine the operational status of the air navigation aids in question after completing the flight inspection and notify the ground ATSEP whether or not the air navigation aid passed or failed the flight inspection.

7.3.2 ANSP shall prepare a report of flight inspection results within 14 days after completion of the flight inspection and notify the ground ATSEP in the aerodrome location. An immediate report shall be made to the Authority of any air navigation aid that fails flight inspection.

7.3.3 ANSP shall keep commissioning data records of the air navigation aid in question until its permanent disuse and shall keep records of scheduled inspections and other flight inspections for at least 5 years.

7.3.4 Ground ATSEP of the airport in question shall complete the following actions: -
i) Take action as per the advice of Flight Inspector;
ii) Take relevant measurements on ground for establishing a meaningful correlation with the flight check results;
iv) Implement the suggestions in the final report and
v) The ANSP shall collate all post flight Inspections reports of all concerned airports, prepare executive summary in appropriate spreadsheet comparing the ground check with the flight inspection results and forward same to the Authority not later than 14 days after the exercise in the format showing Appendices B -E

NOTE: In addition to the attachment of flight inspection report print-out from the flight inspection aircraft recorder, the executive summary, shall be presented by the ANSP in the following format in Appendices B-E.

7.3.5 Where there is a peculiar safety critical major change in the facility flight inspection results that clearly show data deterioration, the ANSP shall immediately withdraw or declassify the facility to a lower category through NOTAM until such repairs are made and service restored and useable.

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Appendix A

Template of flight Inspection plan for the period **DD/MM/YY** to **DD/MM/YY** prepared on **DD/MM/YY.**

S/N	STATION	RUNWAY	FACILITY	DATE OF LAST Ground Check	PERIODI CITY	DATE OF LAST FLIGHT INSPECTION	STATUS OF LAST FLIGHT INSPECTION	DUE DATE OF FLIGHT INSPECTION	PROPOSED DATE OF FLIGHT INSPECTION	TYPE OF INSPECTION (Site approval, Commissioning , Periodic, Surveillance, or Special)	REMARKS

APPENDIX B

Template of the executive summary, spreadsheet expected from the ANSP shall be presented as follows:

Spreadsheet of Executive summary for Flight Inspection Carried out from:
DD/MM/YY to **DD/MM/YY**
Date of Report: DD/MM/YY

VOR **Parameters must be measurable to the accuracy shown in table 1 of this AC.**

STATION	RUNWAY	PARAMETER	FLIGHT INSPECTION DATA			GROUND CHECK DATA			ACTION REQUIRED	REMARKS
			Measured	Tolerance	Max Uncertainty	measured	Tolerance	Max Uncertainty	NOTAM, Repairs, Withdrawal	Useable, Unusable
LAGOS		**Azimuth accuracy alignment, Bends, Roughness, and Scallop**	Deviation							
		Coverage	Field strength							
		Modulation	Modulatio n depth							
		Bearing Monitor	Deviation							

APPENDIX C

DME Subsystem **Parameters must be measurable to the accuracy shown in table 2 of this AC.**

STATION	RUNWAY	PARAMETER	FLIGHT INSPECTION DATA			GROUND CHECK DATA			ACTION REQUIRED	REMARKS
			measured	Tolerance	Max Uncertainty	measured	Tolerance	Max Uncertainty	NOTAM, Repairs, Withdrawal	Useable, Unusable
LAGOS		Range Accuracy	Distance							
		Coverage	Field Density							

APPENDIX D
Spreadsheet of Executive summary for Flight Inspection Carried out from:
DD/MM/YY to DD/MM/YY
Date of Report: DD/MM/YY

STATION	RUNWAY	PARAMETER	FLIGHT INSPECTION DATA			GROUND CHECK DATA			ACTION REQUIRED	REMARKS
			measured	Tolerance	Max Uncertainty	measured	Tolerance	Max Uncertainty	NOTAM, Repairs, Withdrawal	Useable, Unusable
LAGOS		Alignment	DDM							
		Displacement Sensitivity	DDM							
		Off Course Clearance	DDM							
		Course Structure	DDM							
		Coverage	Field Density							
		Modulation Balance Depth	DDM Modulation Depth							
		Monitor Alignment Displacement Sensitivity Off Course Clearance	DDM DDM DDM Field Strength							

		Power								

ILS LOCALIZER Parameters must be measurable to the accuracy shown in table 3 of this AC.

APPENDIX E

STATION	RUNWAY	PARAMETER	FLIGHT INSPECTION DATA			GROUND CHECK DATA			ACTION REQUIRED	REMARKS
			measured	Tolerance	Max Uncertainty	measured	Tolerance	Max Uncertainty	NOTAM, Repairs, Withdrawal	Useable, Unusable
LAGOS		Alignment	DDM, Angle							
		Displacement Sensitivity	DDM, Angle							
		Off Course Clearance	DDM, Angle							
		Course Structure	DDM							
		Coverage	Field Density							
		Modulation Balance Depth	DDM Modulation Depth							
		Monitor Alignment	DDM, Angle							
		Displacement Sensitivity	DDM							
		Power	Field Strength							

ILS GLIDE PATH Subsystem Parameters must be measurable to the accuracy shown in table 4 of this AC.

APPENDIX F

DME Subsystem **Parameters must be measurable to the accuracy shown in table 5 of this AC.**

STATION	RUNWAY	PARAMETER	FLIGHT INSPECTION DATA			GROUND CHECK DATA			ACTION REQUIRED	REMARKS
			measured	Tolerance	Max Uncertainty	measured	Tolerance	Max Uncertainty	NOTAM, Repairs, Withdrawal	Useable, Unusable
LAGOS		Range Accuracy	Distance							
		Coverage	Field Density							

APPENDIX G

Airfield Lighting Parameters must be measurable to the accuracy shown in table 6 of this AC.

STATION	RUNWAY	PARAMETER	FLIGHT INSPECTION DATA			GROUND CHECK DATA			ACTION REQUIRED	REMARKS
			measured	Tolerance	Max Uncertainty	measured	Tolerance	Max Uncertainty	NOTAM, Repairs, Withdrawal	Useable, Unusable
LAGOS		Visual glidepath angle	Elevation degrees							
		Coverage	Azimuth, degrees from approach angle							