Chapter 7 INSTRUMENT LANDING SYSTEM

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Introduction

1. The instrument landing system (ILS) – ARI 18227 – is provided as a short range landing approach aid giving the pilot aural and visual indications of the aircraft's position with relation to a prescribed flight path. The installation provides a radio guide along an approach path to a runway and enables the aircraft to descend to a low altitude without external visual aid. Indications on the pilot's navigation display enable the pilot to align the aircraft to the flight path while aural and visual presentations provide identification of the localiser and marker beacons, situated at the upwind end of the runway and along the approach path to the runway respectively.

2. A brief description of the system together with the indications obtained during operation, servicing and function testing of the equipment is in this Chapter. The servicing diagrams associated with this Chapter and information regarding the location of components complete with a list of associated Air Publications is contained in the relevant chapter of A.P.101B-1202-10A. Technical details and maintenance procedures of the ILS components are in A.P.116B-0443-1 (2nd Edition) while the principles of operation of an ILS airborne installation are in A.P.116B-0401-1.

Modification standard

3. This Chapter includes Mod 1389, 1483, 1511, 1591 and 1721, and STI/Bucc/288.

DESCRIPTION

General

4. The main components of the system are as follows:-

Localiser/glide path receiver
Marker receiver
Pilot's navigation display
(IFIS, *Sect.* 7, *Chap.* 8)
Localiser aerials (two)
Matching unit
Glide slope aerial
Marker aerial

5. The ILS visual indications are presented on the navigation display, while the control and switching arrangements are on the display and the localiser/glide path receiver. Audio tone signals, providing identification of the localiser and marker beacons are received on the aircrew's headphones via the CASS (*Chap.* 2, *this Section*), A marker receiver is employed to process signals from the marker beacons at the side of the runway approach and route the signals suitably to operate a flashing lamp on the display and produce keyed tones in the pilot's headset.

System components

Localiser/glide path receiver

6. This unit, G, marked ILS on the pilot's starboard console, panel C-F/4, is of modular construction and incorporates a localiser receiver, a glide path receiver, frequency synthesiser and power supply modules together with an audio amplifier. A five figure digital display marked MHz, incorporated on the front face together with four associated thumbwheel switches, and a further three-position function switch marked ILS–OFF–VOR (VOR not used) are employed in the control and switching arrangements.

7. Both the localiser and glide slope receivers employ double superheterodyne circuits with wide dynamic range a.g.c. The first local oscillator signal for each receiver is provided by the frequency synthesiser which is controlled by the thumbwheel switches. The pilot selects by these switches the appropriate localiser frequency and consequently the synthesiser automatically determines, by pairing logic, the attendant glide slope frequency. The first (left hand) figure of the digital display remains constant denoting figure 1 while the remaining four figures are each controlled by its respective switch, the localiser frequency range being from 108.05 MHz to 111.95 MHz.

8. *Glide slope channel.* Range signals of 329.3 MHz to 335 MHz from the glide slope beacons are fed via the glide slope aerial (*para* 22) to the receiver. Of two transmitted beams, the upper beam of the glide slope transmission is modulated by a 90-Hz signal and the lower beam modulated by a 150-Hz signal. The difference in depth of modulation (DDM) is fed to a differential amplifier in the unit which consequently produces a d.c. output (deviation) proportional to the DDM, and this output is employed to operate a glide slope flag (G) and to move a horizontal bar, representing the glide slope, on the pilot's IFIS navigation display (*para* 15).

9. When the signals are of the appropriate amplitude and equal, the circuit is in balance, the glide slope bar assumes the central position on the display bisecting a fixed index mark and the aircraft is on the correct glide slope. If the aircraft flies above or below the glide slope, the circuit is unbalanced and the glide slope bar assumes a position below or above the index respectively, the amount of bar displacement being proportional to the out of balance signal. If the output signal falls below a preset level, a G indication in a window on the display is revealed and further indications of the glide slope bar for navigational purposes are to be ignored.

10. *Localiser channel.* Signals from the localiser beacon at the upwind end of the

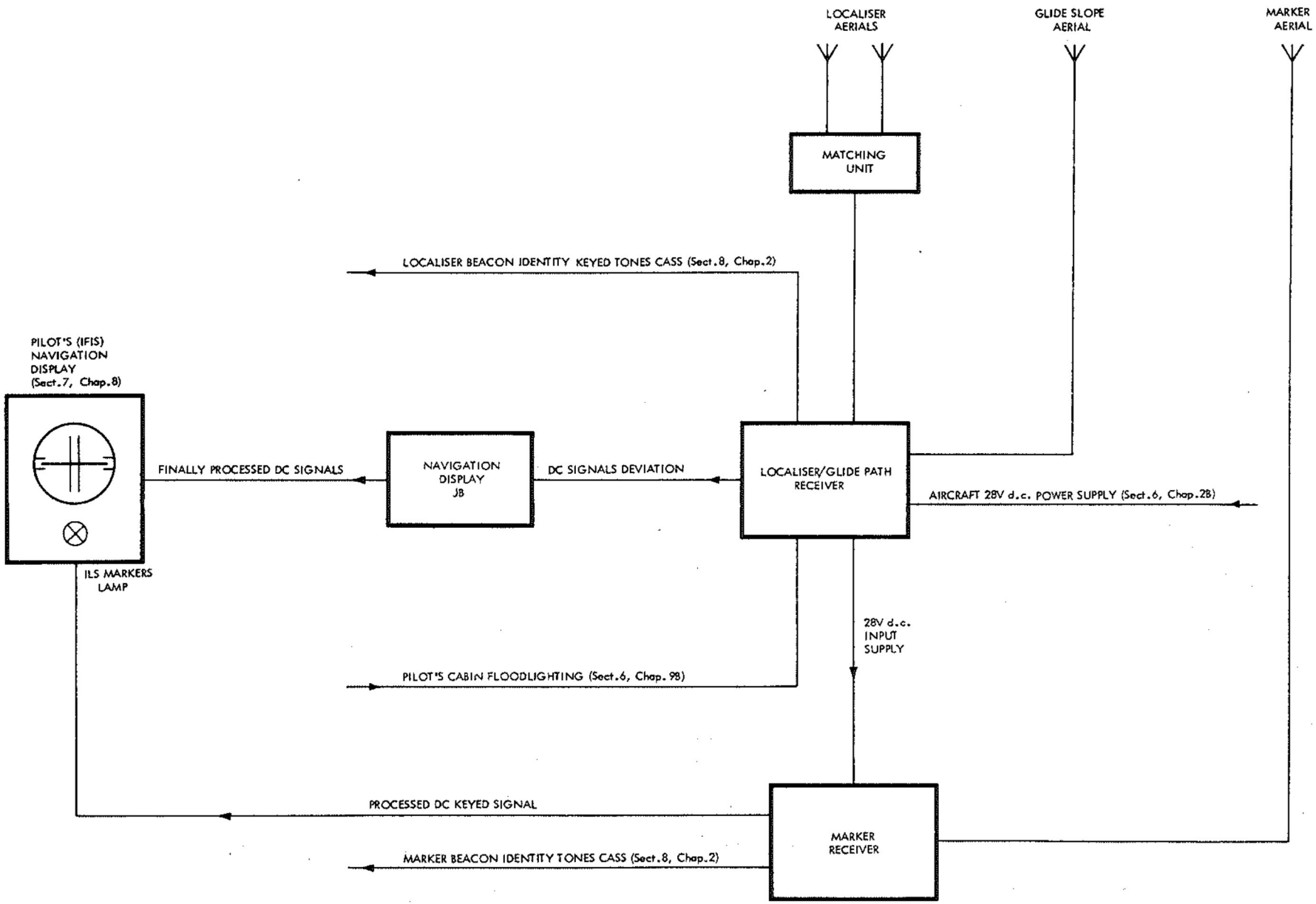

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Fig.1. Information flow diagram

runway are routed via the localiser aerials and matching unit (*para* 21) to the localiser receiver module. The signals are processed and compared to obtain, as in the glide slope channel, a d.c. output signal from the 90-Hz and 150-Hz modulation signals. The output signal in this instance is used to operate a localiser beam flag (B) and move a pair of vertical parallel lines (in the lateral sense) on the roller blind of the pilot's display, the localiser datum being a fixed index on the roller blind carriage. If the output signal falls below a preset level, the operating conditions equally apply as for the glide slope channel except that in this case the B flag is employed to indicate signal failure.

11. The localiser d.c. output is also fed via an audio amplifier in the power supply module (*para* 6) to the CASS (*Chap.* 2, *this Section*) and on selection of the ILS push-button(s) to be heard as a localiser beacon identity tone in the aircrew's headset. The localiser/glide path receiver is connected into the system via a 37-pole connector and two coaxial connectors from the localiser and glide slope aerial feeders. Illumination for the unit front face and thumbwheel switches is provided by the pilot's cabin floodlighting circuit (*Cover* 1, *Sect.* 6, *Chap.* 9B).

Marker receiver

12. This unit, F, on panel C-F/5, incorporates a superheterodyne circuit with two-stage a.g.c. and is used to detect a relatively high-level signal and to reject all the known interfering frequencies. The circuitry includes a band-pass filter, mixer, audio amplifier and lamp driver, the crystal-controlled filter being tuned to an input frequency of 75-MHz. Signals from the marker beacons on the runway approach are received by the marker aerial (*para* 23) as the aircraft passes overhead, and the input signals are then routed via the coaxial feeder and plug and socket connectors to the receiver.

13. The signals are processed through the filter, mixer and detection circuitry, thence via the audio amplifier to emerge as a suitable amplified a.f. signal for routing to the CASS (*Chap.* 2, *this Section*) to be heard as keyed tones in the pilot's headset. The keyed tones vary according to the type of marker beacon being received, outer, middle and inner beacons being identified by different modulation frequency and keying tones. Signals in synchronism with the keyed tones are also passed via a filter and lamp driver circuit in the unit to illuminate an ILS MARKERS lamp at the pilot's display unit (*para* 15) the lamp flashing simultaneously with the received keyed tones.

14. The unit is connected into the system via a 12-pole connector, while its 28-V d.c. power supply is switched via the localiser/glide path receiver function switch (*para* 6) to pin 1 of the connector.

Note...

STI/Bucc/288 inhibits the marker beacon identity audio tone from the marker receiver to the pilot's headset pending modification action to the marker receiver unit.

Pilot's navigation display (fig 2)

15. This instrument is essentially a component of the IFIS (*Sect.* 7, *Chap.* 8, *this Cover*) and is only discussed in this Chapter where its association with the ILS is affected. Fig 2 shows the display presentation with the display mode selector switch selected to ILS. When the localiser beam and glide slope signals are of sufficient amplitude for reliable directives of the display to be used for navigational purposes, two oblong, amber translucent windows marked BEAM and GLIDE respectively,

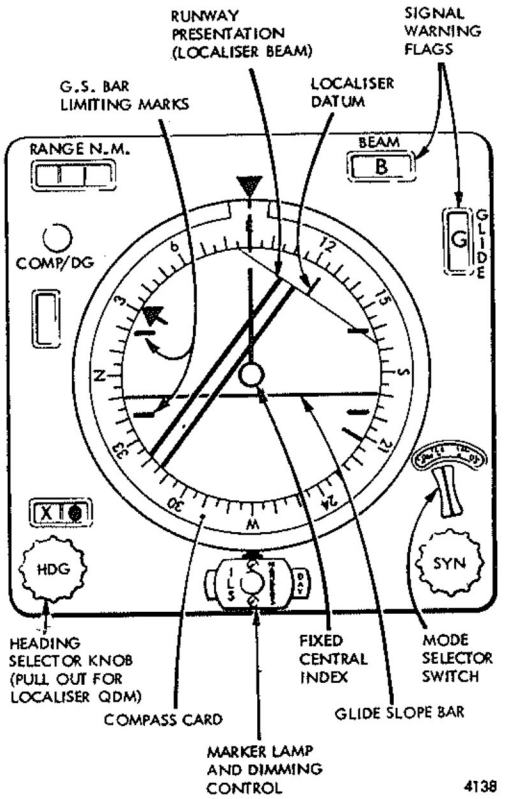

Fig.2. Pilot's navigation display – ILS mode

are obscured by shutters. In the event of either of these signals falling below operational strength, an illuminated B or G is revealed in the window(s) as appropriate.

16. *Localiser beam.* The localiser beam is represented on the display blind by a pair of parallel lines, and lateral displacement of these lines from a localiser datum represents the displacement of the aircraft from the beam. The localiser datum is a fixed vertical line on the roller blind carriage viewed through an aperture in the blind. When the localiser signal strength decreases such that the B indication in the horizontal window is revealed, further indications of the parallel lines for navigational purposes must be ignored. With the

signal strength increasing such that the B indication is obscured, the localiser beam indications may again be used.

17. To enable the pilot to have a plan view of his position relative to the localiser beam during an ILS approach, the localiser datum marker may be set against the compass card after first obtaining the localiser QDM of the runway in use. The datum marker is then set by pulling out and rotating the heading selector (HDG) knob at the lower left of the display.

18. *Glide slope bar.* A white horizontal bar, representing the glide slope, is positioned between the compass card and the roller blind. The glide slope bar represents the position of the centre of the glide slope beam relative to the aircraft, displacement being indicated with respect to a fixed central index marked on the display front glass representing the nose of the aircraft. The operational limitations regarding indications of signal strength of the glide slope beam are to be observed as for those described in para 16 except that in this instance the indications are the glide slope bar and a vertical window with an illuminated G indication.

19. *Marker lamp.* At the central lower face of the display is a lamp with blue filter marked ILS MARKERS, which incorporates a horizontal slider marked NIGHT and DAY used to control the lamp intensity. The lamp is flashed in synchronism with the keyed tones from the marker receiver (*para* 12) indicating to the pilot by the frequency and duration of the flashes, the identity of the marker beacon that the aircraft passes over.

Note...
With the display mode selector switch set to ILS the instrument continues to provide compass indications.

Localiser aerials
20. Two omni-directional, dipole VHF aerials, F-AP (port) and F-AQ (stbd), are mounted one on each side of the fin. The aerials, which receive signals from a localiser beacon at the upwind end of the runway, are connected by coaxial cables and feeders via a matching unit (*para* 21) to the localiser/glide path receiver (*para* 6).

Matching unit
21. This unit, F-AR, is in the fin and forms a three-way coaxial junction between the port and starboard localiser aerials (*para* 20) and the localiser/glide path receiver (*para* 6). The signals from the localiser beacon are paired and the matched result is connected by coaxial feeder to the receiver unit.

Glide slope aerial
22. The glide slope aerial, N-FC, is in the port side of the folding nose, flush with the aircraft skin, oblong in shape and covered with a dielectric panel. Coaxial cable and connectors connect the aerial directly to the localiser/glide path receiver (*para* 6). The aerial is matched to a frequency range of 329.3 MHz to 335 MHz, accepting signals from the glide slope beacon at the side of the runway at the approach end.

Marker aerial
23. The marker aerial, A-DJ, located on the underside of the fuselage on the aircraft centre line, is mounted on the rear accessories bay door. The aerial protrudes from the aircraft skin, is wedge-shaped and matched to accept transmission frequencies of 75 MHz from the airfield marker beacons sited along the approach path to the runway. Coaxial cable and connectors connect the aerial to the marker receiver (*para* 12).

Power supplies
24. The ILS is supplied with 28-V d.c. power requirements from the aircraft secondary electrical installation (*Cover* 1, *Sect.* 6, *Chap.* 2B). The supply is fed from fuse J11 on panel C-Q to pin 22 of the 37-pole connector at the localiser/glide path receiver, while illumination power requirements are detailed in para 11.

OPERATION

25. For an ILS presentation on the pilot's navigation display with associated audio reception on the headphones during on ILS approach, the following operations must be performed:-

(1) Select at localiser/glide path receiver G, on panel C-F/4, the three-position function switch to ILS.

(2) Select the frequency selectors on the receiver unit to the appropriate frequency of the localiser beacon.

(3) At the pilot's navigation display (*Sect.* 7, *Chap.* 8, *this Cover*) select the mode selector switch to ILS.

(4) At the pilot's CASS station box (*Chap.* 2, *this Section*) depress the ILS push-button and adjust its volume control for an acceptable audio output (*see Note to para* 14).

(5) At the display, observe that the beam (B) indication in the horizontal window, and the glide (G) indication in the

vertical window, are not visible, thus indicating that the signal voltages to operate the parallel lines and the glide slope bar are of an acceptable value.

(6) When the marker beacon keyed tones (*see Note to para* 14) are heard in the pilot's headset, observe that the ILS MARKERS lamp at the lower face of the display flashes in synchronism with the tones.

SERVICING

General

26. The installation components must be regularly inspected for signs of damage and/or insecurity. Ensure that aerials are free from corrosion and secure in their mountings and that all plugs and sockets are correctly mated and securely tightened. Cables and connectors must be examined for signs of damage and deterioration and fuses (*para* 28 (2)) are fitted and serviceable. Clips securing cables to the aircraft structure must be inspected for signs of looseness. Insecure clips should be tightened as necessary to prevent chafing.

ILS tests

27. ILS tests including functionals may be performed on the ground using the following equipment:-

(1) 200-V, 3-phase, 400-Hz a.c. ground supply

(2) Centimeter graticule scale

(3) ILS/VOR ramp test set CRM 555, Ref No. 6625-99-956-0026

(4) Headsets (two)

Test preparation

28. (1) Connect and switch on external electrical power supply.

(2) Ensure that the following fuses are fitted and serviceable:-

PANEL	FUSE	RATING
C-Q	C6	5 amp
C-Q	J11	2.5 amp
R-A	3A3	5 amp
R-A	3C3	5 amp
R-A	D2	5 amp
R-AW	P	3 amp
R-AW	Q	3 amp

(3) Plug in an intercom headset in each cockpit.

(4) At junction box R-AW, select IFIS ISOLATION SWITCH to ON.

(5) At the ILS localiser/glide path receiver G on panel C-F/4 select the function switch to ILS.

(6) At the pilot's navigation display (*para* 15) select the mode selector to ILS and adjust the HDG control to align the parallel (runway) lines vertically and expose the grey rectangle upper most on the roller blind. Ensure that the runway lines and the horizontal glide slope bar bisect the fixed central index on the front glass of the display.

(7) Using adhesive tape, fit the centimeter graticule scale to the navigation display front glass, ensuring that it is aligned with the runway presentation and the glide slope bar (in the vertical and horizontal sense respectively) and that the parallel lines and glide slope bar are aligned with the central index.

(8) Connect the test set with its power supply cable to the 28-V d.c. test socket C on panel R-E.

(9) Select the test set EXTERNAL 28V DC–OFF–BATTERY switch to EXTERNAL 28V DC and the BATT–RF MON switch to BATT, ensuring that the POWER ON lamp is illuminated.

(10) Using the pilot's cabin floodlighting switch and dimmer controls (*Cover* 1, *Sect.* 6, *Chap.* 9B) ensure that the illumination of the ILS localiser/glide path receiver can be varied.

Test procedure

29. Perform the tests detailed in Table 1.

TABLE 1 ILS tests

Op No.	Action	Navigation display
ILS RECEIVER/LOCALISER TESTS		
1	Position test set adjacent to forward cockpit.	
2	Release the four Dzus fasteners on the ILS localiser/glide path receiver, (*para* 31) and withdraw the unit. At the rear of the receiver, disconnect the aircraft localiser coaxial cable connector B and connect in lieu coaxial test set cable from connector B on the unit to RF ATTENUATED OUTPUT on the test set. Do not disturb other connections on the unit.	
3	Select test set controls; function switch to LOCALISER, DDM switch to 0 dB, LOC/VOR MEGAHERTZ controls to 110.10 MHz, BATT–RF MON switch to RF MON, the RF ATTENUATOR controls to 110 dBm + 11 dBm, and the 1020 ON switch to off.	
4	Select 110.10 MHz on the ILS receiver.	
5	Adjust SET CARRIER control on test set to centralize pointer on adjacent indicator.	
6	Progressively decrease RF ATTENUATOR controls.	At the display ensure that beam (B) window indication remains fully obscured with a setting of not less than 95 dBm.
7	Adjust RF ATTENUATOR to 80 dBm.	Ensure that runway lines are vertical ± 0.2 cm through the central index. This is the central datum for tests and must be noted.
8	Select DDM switch to 4 dB FLY DOWNRIGHT.	Using the graticule scale ensure that runway lines are deflected 1.2 cm ± 0.3 cm to the right of central datum.
9	Select DDM switch to 4 dB FLY UPLEFT.	Using the graticule scale ensure that runway lines are deflected 1.2 cm ± 0.3 cm to the left of central datum.
10	Select DDM switch to 6.6 dB FLY DOWNRIGHT.	Ensure that runway lines are deflected 1.6 cm ± 0.4 cm to the right of central datum.
11	Select DDM switch to 6.6 dB FLY UPLEFT.	Ensure that runway lines are deflected 1.6 cm ± 0.4 cm to the left of central datum.
12	Select DDM switch to 0 dB.	Ensure that runway lines return to the central datum.
13	Repeat operations 3 to 9 and 12 with 108.30 MHz selected on the test set and ILS receiver, then repeat for 111.50 MHz.	

TABLE 1 *(continued)*

Op No.	Action	Navigation display
14	Depress the ILS push-button on the pilot's CASS station box and adjust for maximum audio output.	
15	Select a frequency of 111.50 MHz on the test set and on the ILS receiver.	
16	Select the RF ATTENUATOR switches to 90 dBm and the 1020\ON switch to ON.	Ensure that 1020-Hz tone is heard in aircrew's headset and can be volume controlled by the ILS push-button on the station boxes.
17	Repeat operations 14, 15 and 16 for the observer's station box.	
18	Select the 1020\ON switch to off.	
19	Disconnect test set coaxial cable from connector B on the ILS receiver and reconnect aircraft localiser cable. Disconnect aircraft glide slope aerial at connector C and connect in lieu the test set coaxial cable.	
20	Select test set controls; function switch to GLIDEPATH, DDM switch to 0 dB, GLIDEPATH MEGAHERTZ switch to 334.4 MHz, the BATT–RF MON switch to RF MON and the RF ATTENUATOR controls to 110 dBm + 11 dBm.	
21	Select 110.10 MHz on the ILS receiver.	
22	Adjust test set SET CARRIER control to centralize pointer on adjacent indicator.	
23	Progressively decrease RF ATTENUATOR controls.	Ensure that glide (G) window indication remains fully obscured with a setting of not less than 80 dBm.
24	Adjust RF ATTENUATOR controls to 70 dBm.	Ensure that glide slope bar is horizontal ± 0.2 cm through the central index. This is the central datum for tests and must be noted.
25	Select DDM switch to 2 dB FLY DOWNRIGHT.	Using the graticule scale ensure that glide slope bar is deflected 0.70 cm ± 0.2 cm below the central datum.
26	Select DDM switch to 2 dB FLY UPLEFT.	Ensure that glide slope bar is deflected 0.70 cm ± 0.2 cm above the central datum.
27	Select DDM switch to 3.76 dB FLY DOWNRIGHT.	Ensure that glide slope bar is deflected 1.2 cm ± 0.2 cm below the central datum.
28	Select DDM switch to 3.76 dB FLY UPLEFT.	Ensure that glide slope bar is deflected 1.2 cm ± 0.2 cm above the central datum.

TABLE 1 *(continued)*

Op No.	Action	Navigation display
29	Select DDM switch to 0 dB.	Ensure that glide slope bar returns to central datum as in operation 24.
30	Repeat operations 24, 25 and 26 with the test set and ILS receiver simultaneously selected to the following paired frequencies:-	
	Test set GLIDEPATH MEGAHERTZ: 329.3 / 330.2 — ILS receiver MHz: 108.90 / 110.70	
31	Select DDM switch to 0 dB.	Ensure that glide slope bar returns to central datum.
32	Disconnect test set coaxial cable from connector C on the ILS receiver and reconnect aircraft glide slope aerial feeder at connector C. Refer to para 32 and, observing the Caution, replace receiver and secure it in position with the four Dzus fasteners.	
MARKER RECEIVER TESTS		
33	Release the two Dzus fasteners on the marker receiver (*para* 12), withdraw the unit and disconnect aircraft marker aerial feeder, connector B, and connect in lieu test set coaxial cable to the RF ATTENUATED OUTPUT on the test set.	
34	Select test set function switch to MARKER 400 Hz, and RF ATTENUATOR controls to 110 dBm + 11 dBm.	Ensure that ILS MARKERS lamp is extinguished.
35	Adjust SET CARRIER control to centralize pointer on indicator.	
36	Progressively decrease RF ATTENUATOR controls.	Ensure that ILS MARKERS lamp is illuminated at not less than 60 dBm.
37	Repeat operations 34, 35 and 36 with the function switch selected to MARKER 1300 Hz and then MARKER 3000 Hz.	
AUDIO TESTS (*see Note to para* 14)		
38	Select test set controls as in operations 34 and 35.	
39	Select RF ATTENUATOR controls to 60 dBm.	Ensure that a 400-Hz tone is heard in the aircrew's headsets.

TABLE 1 *(continued)*

Op No.	Action	Navigation display
40	Repeat operations 38 and 39 with the function switch selected to MARKER 1300 Hz and then MARKER 3000 Hz.	
41	Disconnect the test set coaxial cable at the marker receiver connector B, and reconnect the aircraft marker aerial feeder. Replace marker receiver in the console and secure it in position with the two Dzus fasteners.	
SYSTEM FUNCTION TEST		
Localiser		
42	At the test set connect test coaxial cable to RF ATTENUATED OUTPUT. Arrange test set so that test set aerial is not screened from aircraft localiser aerials.	
43	Select function switch to LOCALISER, DDM switch to 0 dB, LOC/VOR MEGAHERTZ controls to 110.10 MHz, BATT–RF MON switch to RF MON, 1020 ON switch to ON and the RF ATTENUATOR controls to 0 dBm.	
44	Select 110.10 MHz on the ILS receiver.	
45	Adjust SET CARRIER control on test set to centralize pointer on indicator.	Ensure that beam (B) window is fully obscured and that runway lines are vertical ± 0.3 cm through the central datum.
46	Repeat operations 8, 9 and 12.	
Glide Slope		
47	Arrange test set so that test set aerial is not screened from aircraft glide slope aerial.	
48	Select function switch to GLIDEPATH, DDM switch to 0 dB, GLIDEPATH MEGAHERTZ switch to 334.4 MHz, BATT–RF MON switch to RF MON and the RF ATTENUATOR controls to 0 dBm.	
49	Select 110.10 MHz on the ILS receiver.	
50	Adjust SET CARRIER control on test set to centralize pointer on indicator.	Ensure that glide (G) window is fully obscured and that glide slope bar is horizontal through the central datum ± 0.2 cm.
51	Repeat operations 25, 26 and 29.	

TABLE 1 *(continued)*

Op No.	Action	Navigation display
Marker		
52	At the test set connect test aerial to HIGH LEVEL MARKER OUTPUT and arrange test set so that test set aerial is adjacent to and unscreened from the aircraft marker aerial.	
53	Select function switch to MARKER 400 Hz.	Ensure that ILS MARKERS lamp is illuminated.
54	Disconnect test set and its power supply cable.	
55	Select IFIS ISOLATION SWITCH to OFF.	
56	Select ILS receiver function switch OFF.	
57	Disconnect ground electrical power supply.	

REMOVAL AND INSTALLATION

General

30. Before removing or installing any components of the system the aircraft must be rendered electrically safe (*Cover* 1, *Sect.* 6, *Chap.* 1). After installation of any component the tests detailed in Table 1 must be performed to ensure correct operation of the system.

Localiser/glide path receiver

Removal

31. Release the four Dzus fasteners on the face of the receiver and withdraw, the unit. Disconnect the 37-pole connector (A) and the two coaxial aerial feeder connectors (B and C).

Installation

Caution...

The localiser/glide path receiver is retained on the console by four Dzus solid lock fastener studs, each of which incorporates a variable step cam. On installing, locate the unit in position on the console; turn the studs counter-clockwise until fully extended, then turn studs clockwise to tighten. Do not tighten beyond the third 'click' position.

32. Installation is the reverse of removal.

Marker receiver

Removal

33. Release the two Dzus fasteners on the face of the receiver and withdraw the unit. Disconnect the 12-pole connector (A) and the coaxial aerial feeder connector (B).

Installation

34. Installation is the reverse of removal.