APPENDIX A TO CHAPTER 4

(SAMPLE) FLIGHT INSPECTION REPORT

FACILITY TYPE: ILS
NAME & IDENT: XXXXXXX, XX. XXX02
FI TYPE: ROUTINE

INSPECTED: 19 Nov 1996 18:32:14

FI SYSTEM: AIRCRAFT REGISTRATION NUMBER
INS 1 S/N: 1218
INS 2 S/N: 1580
DFIS S/W REV: 8.037
DFIS DB REV: 7.02 14 Nov 1996 14:39:13
SCAPE S/W REV: 27
SCAPE DB REV: 7.02 14 Nov 1996 14:39:13

WE THE UNDERSIGNED CERTIFY

THAT THE FACILITY MEETS OPERATIONAL REQUIREMENTS

PILOT: XXXXX XXXXXX

SIGNATURE: ______________________________ DATE: ____________

THAT THE RADIATED PARAMETERS ARE WITHIN TECHNICAL TOLERANCES

TECHNICAL OFFICER: XXXXXX XXXXXX

SIGNATURE: ______________________________ DATE: ____________

FI_REPORT for: XX02 ILS DATE: 19 Nov 1996 TIME: 18:32:14 Page: 1
FI RUN DIRECTORY FOR: ILS XXXXXXX, XX . XXX02

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RUN DESCRIPTION TX# RUN STATUS DISK DATE TIME

1 SCAPE INITIALIZATION RUN 1 COMPLETE 1 19 Nov 1996 16:14
2 LOC ALIGN/STRUCTURE OPT 1 1 FI REPORT 1 19 Nov 1996 16:25
3 LOC 150 Hz 1/4 CW 1 FI REPORT 1 19 Nov 1996 16:34
4 LOC 90 Hz 1/4 CW 1 FI REPORT 1 19 Nov 1996 16:40
5 LOC ALIGN/STRUCTURE OPT 1 2 FI REPORT 1 19 Nov 1996 16:49
6 LOC 150 Hz 1/4 CW 2 FI REPORT 1 19 Nov 1996 16:58
7 LOC 90 Hz 1/4 CW 2 FI REPORT 1 19 Nov 1996 17:06
8 LOC COURSE CLEARANCE OPT 2 1 FI REPORT 1 19 Nov 1996 17:10
9 GP ALIGN/STRUCTURE 1 FI REPORT 1 19 Nov 1996 17:23
10 GP 150 Hz 1/4 CW OPT 1 1 FI REPORT 1 19 Nov 1996 17:40
11 GP 90 Hz 1/4 CW 1 FI REPORT 1 19 Nov 1996 17:47
12 GP ALIGN/STRUCTURE 2 FI REPORT 1 19 Nov 1996 17:57
13 GP 150 Hz 1/4 CW OPT 1 2 FI REPORT 1 19 Nov 1996 18:05
14 GP 90 Hz 1/4 CW 2 FI REPORT 1 19 Nov 1996 18:14
15 GP COURSE CLEARANCE OPT 11 FI REPORT 1 19 Nov 1996 18:24

AIRCRAFT ANTENNA GAIN FACTORS USED (dB)

ANTENNA	FWD	AFT	STAR	PORT
NAV TOP	27.5	24.5	21.6	22.7
NAV BOT	18.0	18.0	18.0	18.0
GP LEFT	24.7	0.0	0.0	0.0
GP RIGHT	25.6	0.0	0.0	0.0
MKR	22.5	22.5	22.5	22.5
ADF	0.0	0.0	0.0	0.0

GPS SIGNAL GAIN / LOSS FACTORS USED (dB)

	ANT Gain	AMP Gain	NOISE	ANT->SA Loss	ANT->Rx Loss
L1 Band	-4.5	23.5	3	13.5	10.9
L2 Band	0	0	0	0	0

FLIGHT INSPECTION COMMENTS for FACILITY: XXX02

19 Nov 1996 15:58:43 DFIS DB REV: 7.02 14 Nov 1996 14:39:13
19 Nov 1996 15:58:43 SCAPE DB REV: 7.02 14 Nov 1996 14:39:13
19 Nov 1996 15:58:43 STATION TEMPERATURE -19 [Deg C]
19 Nov 1996 15:58:43 XXXXXXX/XX
19 Nov 1996 15:58:43 N 90:00 S-90:00 E-110:00 W-130:00
19 Nov 1996 15:58:45 Antenna factor for C-GCFI Rev 3.01 17 Jul 1996
19 Nov 1996 16:01:18 FI CAL Verify of LOC1 : PASSED @ 110.3 MHz
19 Nov 1996 16:03:39 FI CAL Verify of GP1 : PASSED @ 335 MHz
19 Nov 1996 18:30:39 LOC BACK COURSE PILOT EVALUATION: SATISFACTORY.
19 Nov 1996 18:31:05 FLIGHT TIME = 2.5hrs WX=OC/NC.

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RUN TYPE: LOC ALIGN/STRUCTURE

AS LEFT	RUN No.: 2 TX: 1			RUN No.: 5 TX: 2		
Alignment	AVG (uA)			AVG (uA)		
A - B	1.3			-.3		
Structure	% Course Excursion			% Course Excursion		
P - A	0.0			0.0		
A - B	0.0			0.0		
B - T	0.0			0.0		
	MOD 90 %			MOD 150 %		MOD 90 %
MOD 150 %						
P - A	19.8			19.819.9		19.9
	RF (dBuV/m)	FLAG (uA)	IDENT (%)	RF (dBuV/m)	FLAG (uA)	IDENT (%)
10 NM @ CL	63.4	370.7	9.5	64.4	374.3	9.6

AS FOUND	RUN No.: 2 TX: 1			RUN No.: 5 TX: 2		
Alignment	AVG (uA)			AVG (uA)		
A - B	1.3			-.3		
Structure	% Course Excursion			% Course Excursion		
P - A	0.0			0.0		
A - B	0.0			0.0		
B - T	0.0			0.0		
	MOD 90 %		MOD 150 %	MOD 90 %		MOD 150 %
P-A	19.8		19.8	19.9		19.9
	RF (dBuV/m)	FLAG (uA)	IDENT (%)	RF (dBuV/m)	FLAG (uA)	IDENT (%)
10 NM @ CL	63.4	370.7	9.5	64.4	374.3	9.6

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RUN TYPE: LOC 90 Hz 1/4 CW

AS LEFT	RUN No.: 4 TX: 1	RUN No.: 7 TX: 2
A - B	95.9 uA/deg	93.2 uA/deg
	76.7 uA	74.5 uA

AS FOUND	RUN No.: 4 TX: 1	RUN No.: 7 TX: 2
A - B	95.9 uA/deg	93.2 uA/deg
	76.7 uA	74.5 uA

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RUN TYPE: LOC 150 Hz 1/4 CW

	AS LEFT RUN No.: 3 TX: 1	RUN No.: 6 TX: 2
A - B	96.5 uA/deg	90.2 uA/deg
	-77.2 uA	-72.1 uA

	AS FOUND RUN No.: 3 TX: 1	RUN No.: 6 TX: 2
A - B	96.5 uA/deg	90.2 uA/deg
	-77.2 uA	-72.1 uA

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RUN TYPE: LOC COURSE CLEARANCE

	AS LEFT TX: 1	TX: 2
	RUN: 8 FC	RUN: 8 BC
	MODE: NORMAL	MODE: NORMAL
	MIN CP(uA)	MIN CP(uA)
+35 TO +10	335.0	321.1
-35 TO -10	-365.0	-347.6
-10 TO +10	PASS	PASS

	AS FOUND TX: 1	TX: 2
	RUN: 8 FC	RUN: 8 BC
	MODE: NORMAL	MODE: NORMAL
	MIN CP(uA)	MIN CP(uA)
+35 TO +10	335.0	321.1
-35 TO -10	-365.0	-347.6
-10 TO +10	PASS	PASS

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RUN TYPE: GP ALIGN/STRUCTURE

AS LEFT RUN No.: 9 TX: 1 RUN No.: 12 TX: 2

Alignment	AVG (uA)	AVG (uA)
A - B	10.3	9.7

Structure	% Path Excursion	% Path Excursion
P - A	0.0	0.0
A - B	0.0	0.0
B - T	0.0	0.0

	MOD 90 %	MOD 150 %	MOD 90 %	MOD 150 %
P - A	39.8	39.8	39.6	39.7

	RF (dBuV/m)	FLAG (uA)	IDENT (%)	RF (dBuV/m)	FLAG (uA)	IDENT (%)
10 NM @ CL	68.5	372.8		68.3	371.4	

AS FOUND RUN No.: 9 TX: 1 RUN No.: 12 TX: 2

Alignment	AVG (uA)	AVG (uA)
A - B	10.3	9.7

Structure	% Path Excursion	% Path Excursion
P - A	0.0	0.0
A - B	0.0	0.0
B - T	0.0	0.0

	MOD 90 %	MOD 150 %	MOD 90 %	MOD 150 %
P-A	39.8	39.8	39.6	39.7

	RF (dBuV/m)	FLAG (uA)	IDENT (%)	RF (dBuV/m)	FLAG (uA)	IDENT (%)
10 NM @ CL	68.5	372.8		68.3	371.4	

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RUN TYPE: GP 90 Hz 1/4 CW

AS LEFT RUN No.: 11 TX: 1 RUN No.: 14 TX: 2

A - B	215.1uA/deg 77.6 uA	235.0 uA/deg 84.7 uA

AS FOUND RUN No.: 11 TX: 1 RUN No.: 14 TX: 2

A - B	215.1 uA/deg 77.6 uA	235.0 uA/deg 84.7 uA

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RUN TYPE: GP 150 Hz 1/4 CW

AS LEFT	RUN No.: 10 TX: 1	RUN No. : 13 TX: 2
A - B	202.0 uA/deg	200.6 uA/deg
	-72.8 uA	-72.3 uA

AS FOUND	RUN No.: 10 TX: 1	RUN No.: 13 TX: 2
A - B	202.0 uA/deg	200.6 uA/deg
	-72.8 uA	-72.3 uA

****

RUN TYPE: GP COURSE CLEARANCE

AS LEFT RUN No.: 15 TX: 1

	MAX CP (uA)	AVG CP (uA)
.3-.45 (NORMAL)	-312.4	*****
A - B (NORMAL)	-168.1	-185.1

AS FOUND RUN No.: 15 TX: 1

	MAX CP (uA)	AVG CP (uA)
.3-.45 (NORMAL)	-312.4	*****
A - B (NORMAL)	-168.1	-185.1

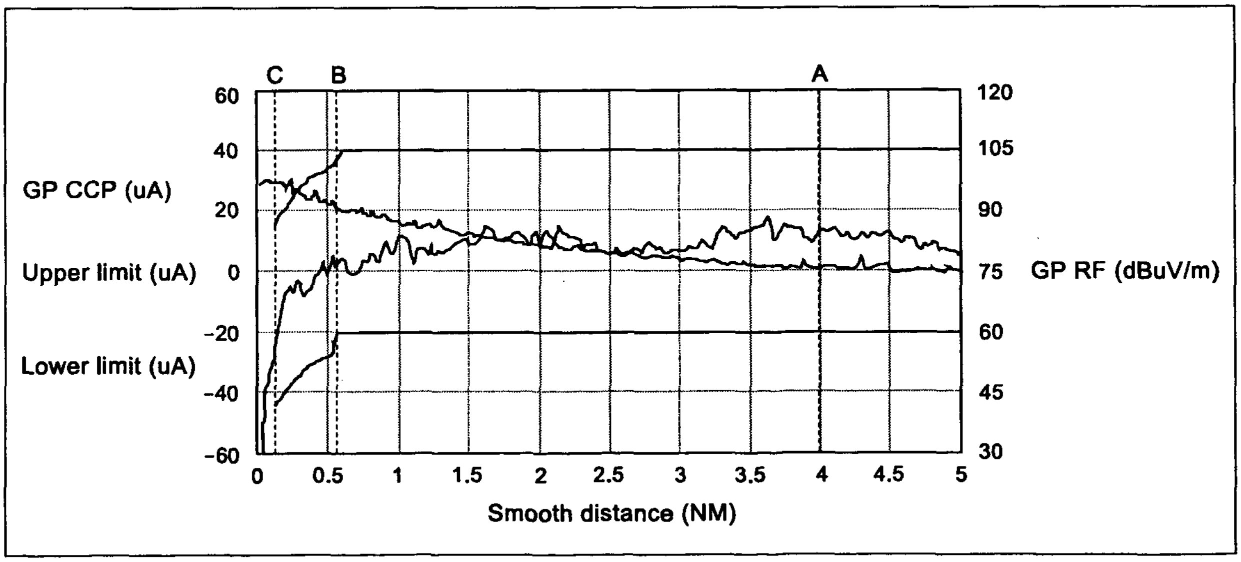

Figure I-4-1 Glide path alignment structure

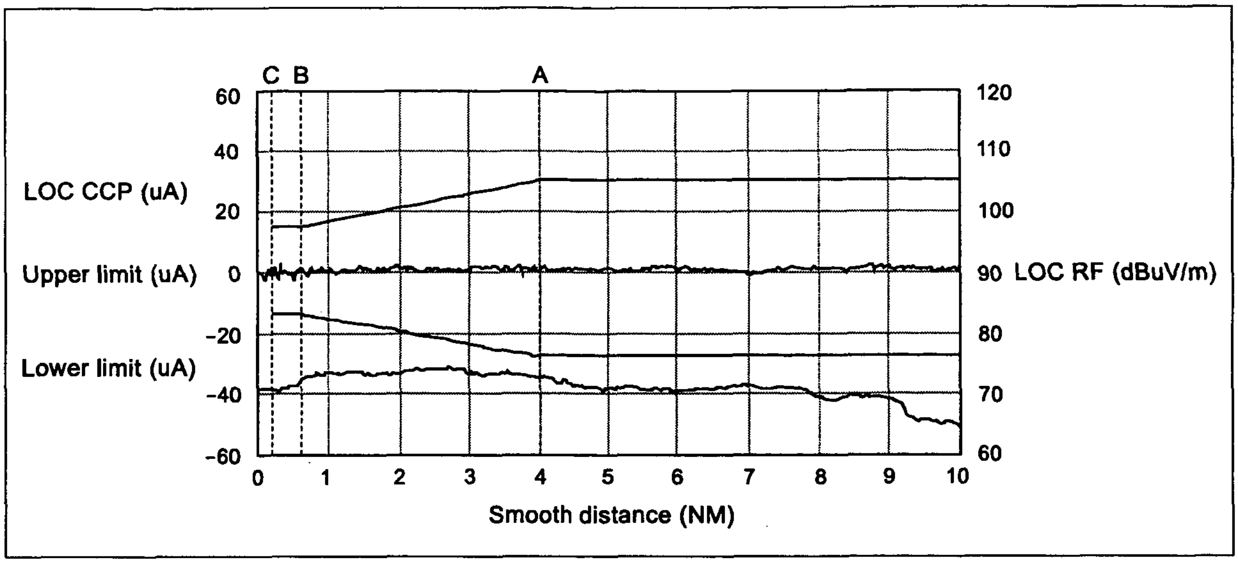

Figure I-4-2. Localizer alignment structure

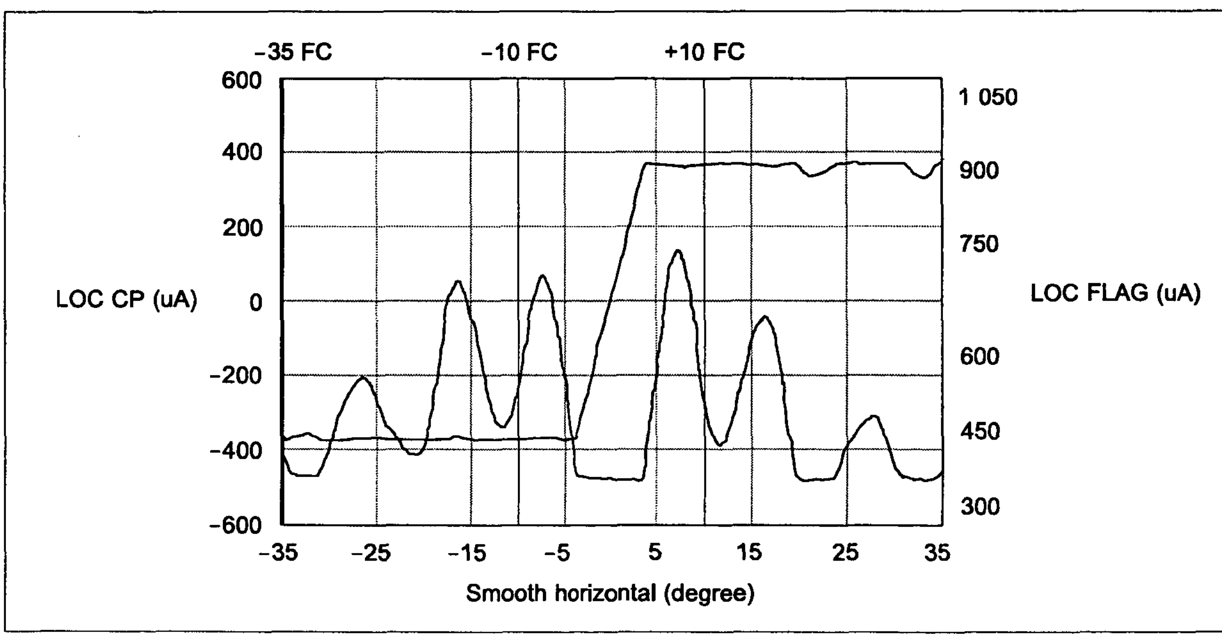

Figure I-4-3. Localizer clearance

Note.— Figure I-4-3 shows values for the Sum of Depth of Modulations (SDM) exceeding 60% at some azimuths. This is common for many antenna systems with small apertures (e.g. a small number of elements) installed on longer runways requiring smaller course widths. Annex 10, Volume I, 3.1.3.5.3.6.1, limiting the SDM to a maximum value of 60% for installations occurring after 1 January 2000. This new limit will not be applied to existing arrays installed before that date.

Chapter 5
NON-DIRECTIONAL BEACON (NDB)

5.1 INTRODUCTION

System description

5.1.1 A non-directional beacon (NDB) (also called a low- or medium-frequency homing beacon) transmits non-directional signals, primarily via ground wave propagation, whereby a pilot can determine the bearing to the ground beacon and "home-in" on it. These facilities operate on frequencies available in portions of the band between 190 and 1 750 kHz with keyed identification and optional voice modulation. The airborne receiver installation is usually called an Automatic Direction Finder (ADF).

Ground equipment

5.1.2 The ground equipment consists of a transmitter, antenna tuner and monitor, with optional standby transmitter, automatic changeover equipment and automatic antenna tuner. The monitor is not always collocated with the transmitter equipment. The transmitter normally transmits a continuous carrier modulated by either 1 020 Hz or 400 Hz keyed to provide identification. In some special cases of high interference or noise levels, the unmodulated carrier is keyed instead. The transmitter power is selected to provide the required minimum coverage, and varies from a few watts to several kilowatts. The antenna system is a vertical radiator, commonly with top loading, with an extensive earth system to improve efficiency and restrict high angle radiation.

Airborne user equipment

5.1.3 Airborne ADF equipment includes an omnidirectional sense antenna and a rotatable loop (or a fixed loop and a goniometer performing the same function). A continuous switched phase comparison process between loop and sense antenna inputs resolves the 180-degree ambiguity that normally exists in the loop input. As part of this process, a servo motor (or electronics) drives the loop (or goniometer) to a balanced position dependent upon the direction of the signal source, and a corresponding synchronous azimuth indication is provided on the aircraft ADF bearing indicator instrument. The performance of the equipment may be degraded if the signal from the NDB is modulated by an audio frequency equal or close to the loop switching frequency or its second harmonic. Loop switching frequencies are typically between 30 Hz and 120 Hz.

Factors affecting NDB performance

Rated coverage

5.1.4 The rated coverage of an NDB is an area in which a specified minimum signal strength of the ground wave is obtained. Provided that an adequate value of signal strength is chosen, there is a high probability of obtaining accurate bearings in this area. However, since other factors (some of which are discussed below) determine whether accurate bearings are obtained, it is necessary to measure the quality of the bearings from the ADF during a flight check to assess the effective coverage of the NDB.

Factors affecting signal strength of ground wave

5.1.5 *Antenna current.* The signal strength obtained at any point throughout the rated coverage area is directly proportional to the current in the vertical radiator of the antenna. Doubling the antenna current will double the strength at a fixed point or double the range for a fixed value of signal strength. The power radiated is dependent on the antenna and ground system efficiency, which varies typically from 2 to 10 per cent. The power dissipated by the NDB transmitter is the sum of the powers radiated and dissipated by the ground system and ohmic losses.

5.1.6 *Ground conductivity.* The transmitter power necessary to drive a given current through the antenna and ground system varies with the soil conductivity at the antenna site. The signal strength of the ground wave also depends on the conductivity of the soil between the transmitter and receiver. The conductivity of seawater is higher than soil, hence the range over seawater is usually greater than over land.

5.1.7 *Altitude.* An increase in signal strength can be expected as the aircraft height is increased, the effect being most marked over soil of poor conductivity, and almost negligible over seawater.

Factors affecting the quality and accuracy of ADF bearings (effective coverage)

5.1.8 *Noise.* The effective coverage is limited by the ratio of the strength of the steady (non-fading) signal received from the NDB to the total noise intercepted by the ADF receiver. The noise admitted to the receiver depends on the bandwidth of the receiver, the level and characteristics of atmospheric noise in the area together with noise sources in the aircraft and the level of the interference produced by other radio emissions. If the signal-to-noise ratio is less than the limiting value, useful bearings cannot be obtained. In some cases, the effective coverage may be limited to the range of a usable identification signal.

5.1.9 *Night effect.* The effective coverage of an NDB is also limited at night when a skywave, reflected from the ionosphere is present at the receiver in addition to the vertically polarized ground wave on which the system depends during the day. The interaction of these two signals from the NDB results in bearing errors in the ADF. The effect is independent of transmitter power.

5.1.10 *Terrain effects.* Errors in ADF bearings are often produced over rugged terrain or where abrupt discontinuities occur in the ground surface conductivity. The effect results in an oscillating bearing and usually diminishes with increasing aircraft altitude.

Testing requirements

5.1.11 A summary of testing requirements for NDB facilities is given in Table I-5-1.

5.2 GROUND TESTING

General

5.2.1 The purpose of ground testing is to ensure that the NDB radiates a signal, which meets the requirements of Annex 10, Volume I, on a continuing basis. Since NDB equipment varies greatly, it is not possible to define detailed tests applicable to all types. Therefore, only a high-level description of the tests is provided. Refer to the manufacturer's recommendations for additional tests and detailed procedures for specific equipment.

Ground performance parameters

5.2.2 Ground test requirements are listed in Table I-5-2.

Ground test procedures

5.2.3 *Carrier frequency.* The carrier frequency should be checked against an accurate frequency standard or counter. Refer to the manufacturer's instructions for detailed procedures.

5.2.4 *Antenna current.* On most equipment, a meter is provided to read the current in the series-resonant antenna system. (If not provided, an RF thermocouple-type ammeter should be temporarily inserted at ground potential in the series resonant antenna tuner circuit.) Any change in this current from its initial value at commissioning could be due to a change in the power delivered from the transmitter and/or a change in the characteristics of the antenna system, including the transmission line and ground system. Changes should be investigated, as the coverage performance of the beacon will be affected.

5.2.5 *Modulation depth.* The modulation depth can be measured by a modulation meter (which may be built into the equipment) or by an oscilloscope. Refer to the manufacturer's instructions for detailed procedures for using a modulation meter. When using an oscilloscope, the modulated signal from the NDB (preferably obtained from a pick-up antenna) is displayed and the modulation depth obtained by measuring the maximum and minimum of the modulation envelope. (The radiated modulation percentage, as observed with a pick-up antenna, may be reduced due to the high Q factor of the antenna system.) If A_{max} and A_{min} are the maximum and minimum of the envelope respectively, then:

$$\text{Modulation } \% = \frac{A_{max} - A_{min}}{A_{max} + A_{min}} \times 100\%$$

5.2.6 *Modulation frequency.* The modulation frequency should be measured using a frequency meter or a counter, or by comparison of the modulation frequency with that generated by an accurate (1.0 per cent) audio generator. Refer to the manufacturer's instructions for the operation of these instruments.

5.2.7 *Modulation depth of power supply frequency components.* A monitor may be installed with some NDB equipment to provide a means of detecting excessive power supply modulation on the carrier. A metering position is usually provided to enable this modulation depth to be read for testing purposes. Alternatively, an oscilloscope can be used to display the NDB signal (with identification modulation removed). By using a suitable time base frequency, modulation at the power supply frequency can be identified.

5.2.8 *Spurious modulation components.* The measurement of the modulation depth of spurious components on the carrier requires the use of a modulation meter or the modulation measuring circuits, which may be incorporated in the monitor. With the identification modulation removed, the residual modulation depth of the carrier is measured.

5.2.9 *Carrier level during modulation.* A change in carrier level with modulation can be measured using a field intensity meter, modulation meter, carrier level meter on the monitor, or an oscilloscope. Using the first three methods, any change in the carrier level indication can be noted by comparing the level with and without identification modulation. (Depending on the detection and metering circuits used in these three methods, the bandwidth of the radio frequency circuits may need to be narrow enough to reject the modulation sidebands.) Using an oscilloscope, a pattern is displayed as described in 5.2.6 and the average carrier level with and without identification modulation is found. The carrier level without modulation can be read directly from the screen, while the average level with modulation is:

$$\frac{A_{max} + A_{min}}{2}$$

5.2.10 *Audio frequency distortion.* The design of the transmitting equipment will usually ensure that modulation distortion is acceptably small. However, if a distorted signal is reported, a measurement should be made of this parameter and appropriate action taken. The usual measuring equipment is a modulation monitor and distortion meter. Detailed procedures for the use of this equipment can be found in the manufacturer's instructions.

5.2.11 *Monitor system.* The monitor system, when provided, should be checked to ensure it will detect erroneous transmissions from the NDB. Some monitors include switching functions that permit fault conditions to be simulated. In other cases, NDB fault conditions should be simulated as closely as possible to check that the monitor will alarm. Detailed procedures can be found in the manufacturer's instructions.

5.2.12 Reserved.

Test equipment

5.2.13 *Test equipment list.* The following test equipment is recommended for NDB ground maintenance:

a) frequency meter, standard, or counter with an accuracy of at least 0.001 per cent (for carrier frequency);

b) RF thermocouple ammeter (if not part of the equipment), for measuring the antenna current;

c) distortion meter or wave analyser, for audio frequencies distortion;

d) frequency meter or standard frequency source with an accuracy of at least 0.5 per cent (for identification frequency measurement) — this instrument can typically be the same as used in a) above;

e) modulation meter or oscilloscope for modulation percentage measurements; and

f) field intensity meter where ground field strength measurements are to be made or where an airborne field strength installation is to be calibrated. The field intensity meter can also be used to check for the radiation of spurious harmonics from the NDB.

5.3 FLIGHT TESTING

General

5.3.1 The primary objectives of flight testing are to determine the coverage and quality of the guidance