

ANS 1.7.026	 CAAI	CNS Inspector Handbook
VHF Direction Finding (VDF) approval		Revision 0
		April 30, 2015

1. Objective

- 1.1. This directive is part of the CNS inspector handbook.
- 1.2. This directive provides guidance for evaluating and approving VHF Direction Finding (VDF) Systems.

2. General

- 2.1. The VDF equipment shall provide indications of known accuracy to ATC of the magnetic bearing to or from the VDF site of aircraft transmitting on associated aerodrome communication frequencies.
- 2.2. 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.
- 2.3. VDF is specifically included in the definition of Aeronautical Telecommunication Service in Article 1 to the ANL, 2011.
- 2.4. This document sets out the requirements for approval of VDF systems established or used within Israel to provide ATS services.

2.5. Abbreviations

ANL	-	Air Navigation Law
ANR	-	Air Navigation Regulations
ATC	-	Air Traffic Control
ANS	-	Air Navigation Service
ATS	-	Air Traffic Service
DOC	-	Designated Operational Coverage
VHF	-	Very High Frequency

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

3.3. ICAO annexes & documents

3.3.1. ICAO Doc. 9426, Air Traffic Services Planning Manual

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

3.4. Forms & Job-Aids – none

4. Process

4.1. Technical Requirements

4.1.1. VDF Categorization

VDF categorization is detailed in ICAO Doc. 9426, Air Traffic Services Planning Manual

Category	Range of Bearing Error	Category Classification
Class A	± 2 degrees	Within 9 km (5 NM)
Class B	± 5 degrees	Within 37 km (20 NM)
Class C	±10 degrees	Within 92 km (50 NM)
Class D	> ±10 degrees	> 92 km (50 NM)

4.1.2. Functional Requirements

4.1.2.1 To achieve the safety objective the accuracy and useful service area of the VDF installation shall be demonstrated by Flight Inspection.

4.1.2.2 VDF Flight Inspection shall be undertaken on Commissioning of new equipment, replacement of aerial system, relocation of equipment or other major adjustment or modification which may cause the accuracy of the equipment to be compromised, or at any other time as required by an ATS Engineering Inspector.

4.1.2.3 The method of flight inspection is not specified in this publication, only the parameters to be measured. Examples of methods of flight inspection include:

4.1.2.3.1. A suitably equipped flight inspection aircraft, using an automatic or semi-automatic positioning or tracking system.

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- 4.1.2.3.2. Positioning an aircraft over previously surveyed ground checkpoints.
- 4.1.2.3.3. Use of a theodolite, sympathetically positioned at the VDF antenna in order to minimize reception induced errors, tracking the target aircraft.
- 4.1.2.3.4. Use of Radar positioning of the aircraft in combination with ground surveyed checkpoints.
- 4.1.2.3.5. Use of GPS equipped aircraft, in combination with ground surveyed checkpoints.
- 4.1.2.4. Use can be made of any suitable method, providing that the positioning accuracy of the aircraft is better than the required accuracy of the VDF by a factor of 5, i.e. Class A/5 = $\pm 0.4^\circ$ aircraft positioning accuracy.

4.1.3. Required Procedures

- 4.1.3.1 The following activities shall be carried out during the commissioning of the VDF

- 4.1.3.1.1. Ground checks

Checks to confirm the bearing accuracy shall be carried out using suitable test oscillator(s) or portable radio equipment, at previously surveyed ground points around the VDF antenna.

Note: Establishment of accurate test points is necessary in order to provide confidence that the alignment of the VDF is correct prior and subsequent to, flight inspection.

Recommendation: Unless otherwise advised by the VDF manufacturer, ground test points should be located every 10 degrees around the VDF antenna.

Recommendation: Periodic confirmation of the bearing accuracy, using ground checks, should be undertaken in accordance with the equipment manufacturer's recommendations.

- 4.1.3.1.2. Checks using Aircraft

- The flight calibration aircraft shall complete an orbit of the VDF, measuring the actual magnetic bearing from the VDF, which shall be compared

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with those indicated by the direction finder display.

Note: It may be necessary to complete orbit flights in both directions in order to eliminate any 'lag error.'

- The height and radius for the flight inspection is dependent on the required operational coverage for the VDF. The flight check shall take place at the limit of the required operational coverage and be at an altitude which will maintain radio line of sight, whilst observing any minimum safe altitude criteria.
- Where the operational coverage is not specified then the limits of the VDF, with its associated communications equipment, shall be established.
- Ground and Air checks may need to be repeated if the equipment is adjusted in order to eliminate errors.
- Areas where out of tolerance errors cannot be corrected or where VHF communication was not of sufficient quality shall be subject to further investigation. Any subsequent limitations to coverage shall be published in the AIP

4.1.3.1.3. Approach Procedures

Any proposed VDF Instrument Procedures shall be flown, with confirmation obtained that the indicated bearing is within tolerance throughout the approach.

4.1.3.1.4. Frequencies

- The foregoing 'Required Procedures' shall be carried out on the primary VDF frequency.
- Bearing accuracy spot checks and full approach procedures shall be carried out on all other communication frequencies associated with the VDF.

4.1.3.1.5. Standby power

Checks at the ground check points shall be repeated using the standby power source, if installed.

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4.1.3.1.6. Test results

- The results shall be assessed for the categorization required.
- The results and supporting evidence shall then be submitted to the CAAI for acceptance and Approval of the facility

4.2. Maintenance of VDF systems

4.2.1. General Requirements

- 4.2.1.1 Maintenance arrangements shall be established to ensure the continued availability and reliability of all VDF systems, associated with the provision of an ATC service.
- 4.2.1.2 All the technicians will be properly trained on the VDF systems.
- 4.2.1.3 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 VDF systems, as or a period of two years.
- 4.2.1.4 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.

4.2.2. Training

- 4.2.2.1 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;
- 4.2.2.2 The training will be according to ICAO Doc 9712
- 4.2.2.3 The training program is accepted by the CAAI
- 4.2.2.4 The training program shall include separate parts according to these details:
 - 4.2.2.4.1. Initial training;
 - 4.2.2.4.2. Periodic training;
 - 4.2.2.4.3. Special training;
 - 4.2.2.4.4. Human factor training;
 - 4.2.2.4.5. Work safety;

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4.2.3. Maintenance program

- 4.2.3.1 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.
- 4.2.3.2 The CAAI approval of the Maintenance Program provides a mechanism to record minimum standards that the service provider must comply with.
- 4.2.3.3 The maintenance program may be applicable to more than one VDF Navigation Radio Stations of the same type.
- 4.2.3.4 The inspector will review the maintenance program according to applicable supporting information provided by the service provider.
- 4.2.3.5 The maintenance program will be design to meet Human Factors principles.
- 4.2.3.6 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.
- 4.2.3.7 The maintenance program should include:
- 4.2.3.7.1. 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

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- 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.

- 4.2.3.7.2. 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).
- 4.2.3.7.3. Forms
- All the forms/log books that are going to be used will be part of the maintenance program.
- 4.2.3.7.4. Additional procedures if required
- 4.2.3.7.5. Permitted variations to maintenance periods

4.3. 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)

4.4. Demonstration and Inspection Phase

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

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- 4.4.2. These demonstrations include actual performance of activities and/or operations while being observed by the inspector.
- 4.4.3. The demonstration will include on-site evaluations of equipment maintenance and support facilities.
- 4.4.4. 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.
- 4.4.5. 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.

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Chapter 6

VHF Direction Finder

6.1 FUNCTIONAL REQUIREMENTS

6.1.1 The VHF direction finder (VDF) is a ground based radio aid used by the operator of a ground station and consists of a directional antenna system and a VHF radio receiver. Each time the aircraft transmits on the frequency to which the VDF is tuned, its display indicates the magnetic direction of the aircraft from the station. Recent equipment presents this information as a digital readout. At a radar equipped ATS unit, the VDF indications may be superimposed on the radar display. Where DF equipment is co-located with radar, a strobe of light flashes from the centre of the radar display in the direction of the radar target representing the transmitting aircraft.

6.1.2 VDF stations may operate independently or in groups of two or more stations under the direction of a main VDF station. A VDF network can supply azimuth as well as position information. In this case, the main VDF station integrates, computes and plots the bearings from the individual VDF stations and from this derives the position of the aircraft so plotted. A single VDF station can determine only the relative bearing of the aircraft, unless this bearing is correlated with a reported, intersecting VOR radial. As VDF relies exclusively on air-ground communications, standby or back-up equipment is normally provided for VDF.

6.1.3 VDF stations are usually located on or near aerodromes, a situation that frequently poses significant problems with siting due to obstructions which reflect signals and due to electronic radiation which interferes with the signals. These disturbances will cause perceived signal errors and consequently incorrect bearing and/or position results. If no suitable site is available at the aerodrome, the VDF antenna may be located elsewhere; however, in this case, the bearing information is then given in relation to the antenna site rather than the aerodrome.

6.1.4 Equipment specifications normally require a bearing accuracy of $\pm 4^\circ$ on the azimuth indicator. This deviation may however be greater depending on site, terrain or other factors. A small additional error is introduced when the strobe line indication is superimposed on the surveillance radar display. VDF equipment furnishes bearing information from any aircraft within communications range transmitting on the selected frequency. Any signal within range affects it. Therefore, when two or more aircraft are transmitting simultaneously on the same frequency, bearing indication is determined by the relative strength of the two signals received.

6.1.5 ICAO provisions classify estimated bearing accuracy as follows:

- a) Class A — within $\pm 2^\circ$
- b) Class B — within $\pm 5^\circ$
- c) Class C — within $\pm 10^\circ$
- d) Class D — $>$ Class C

Similarly, the classification of estimated position accuracy is made in accordance with the following:

- a) Class A — within 9 km (5 NM)
- b) Class B — within 37 km (20 NM)
- c) Class C — within 92 km (50 NM)
- d) Class D — $>$ Class C

6.2 OPERATIONAL APPLICATION

VDF is of particular value in locating lost aircraft, in helping to identify aircraft on radar and to guide aircraft to areas of good weather or to aerodromes. At aerodromes equipped with VDF, instrument approaches based on the use of VDF may be offered to aircraft in a distress or urgency condition.