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DOCUMENT TITLE
# INSTRUMENT RATING

# CHAPTER 4 – INSTRUMENT APPROACHES

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# INSTRUMENT APPROACHES

## 4.1 Introduction

Most of the information relating to instrument approach procedures is contained in the JEPPESEN TERMINAL and on the applicable charts. It is extremely important that you make a careful and thorough study of both.

## 4.2 Instrument Descent Manoeuvres

An instrument approach is a laid down set of procedures which allows the pilot to descend from the lowest safe altitude or minimum safe altitude to an altitude low enough to become visual and then to carry out a landing, whilst at all times maintaining obstacle clearance.

Instrument approaches can be divided into two distinct groups.

- Non-precision instrument approaches, which bring you down to a minimum descent altitude or height (MDA/H).
- Precision instrument approach, which bring you down to a decision altitude or height (DA/H).

## 4.3 Non-Precision Instrument Approaches

Non-precision instrument approaches can be further divided into three distinct groups.

### 4.3.1 Non-Precision Runway Instrument Approach

This is an approach which utilizes, NDB, VOR and LLZ, (most runway approaches incorporate a DME with the directional aid) or RNAV (GNSS) which is a GNSS dependant approach and therefore does not require a ground based navigation aid.

A non-precision runway approach does not always align with the centreline of the runway (with the exception of LLZ approach). A non precision runway instrument approach is one in which at the conclusion of a successful approach no undue manoeuvres are required to align with the centreline.

Where a particular runway is specified in an approach chart identifier (e.g. BUNDABERG, QLD, NDB RWY 14) the approach is referred to as a <u>runway approach.</u>

All runway approaches offer a landing minima and circling minima. The landing minima can only be used by aircraft operating under IFR flight procedures and intending to land on the nominated runway. IFR aircraft wishing to land on a runway other than the runway nominated in the procedure designator, can only descend to the circling minima.

### 4.3.2 Aerodrome Instrument Approach

An aerodrome instrument approach is a pre-determined published approach manoeuvre designed to provide a safe descent path from lowest safe altitude to a minimum descent altitude (MDA) in the vicinity of the destination aerodrome.

An aerodrome approach does not attempt to align an aircraft with a runway or in fact even position the aircraft for landing. It is simply a descent procedure used to establish visual reference near the aerodrome.

Once visual reference is established the aircraft is manoeuvred (circled) around the aerodrome to achieve suitable positioning for a landing. All visual manoeuvring must be carried out within an area known as the circling area.

## 4.4 Precision Instrument Approaches

A precision approach procedure is a standard instrument approach procedure in which an electronic glide slope/path is provided.

Precision approaches used are:

- Instrument Landing System (ILS)
- Microwave Landing System (MLS)
- Precision Approach Radar (PAR)
- Global Navigation Satellite System (GLS).

**Note:** All precision approaches are runway approaches.

### 4.4.1 Instrument Landing System (ILS)

An ILS approach is a runway approach with electronic vertical and lateral guidance. ILS approach charts show ILS DA and localiser LLZ [LOC] MDA and circling minima.

LOC minima are used when the glide path is not available. (This then becomes a non-precision approach).

The CAT 1 minima may be used by all aircraft and the minimum visibility required may be either 1.2 KM or 1.5 KM depending on the availability of high intensity approach lighting (HIAL). *(TERMINAL AU28)*

Microwave Landing System (MLS) The Microwave Landing System is an instrument landing system operating in the Microwave Spectrum which provides lateral and vertical guidance to aircraft having compatible avionics equipment.

### 4.4.2 Pressure Error Correction

In any event, all DA must be adjusted to determine an AOM which accounts for aircraft pressure error. Operators may apply aircraft Pressure Error Correction (PEC) or, alternatively, add at least 50 FT to the published DA. Compensation for aircraft pressure error is not required when determining AOM for non-precision approaches. *(TERMINAL AU17)*

### 4.4.3 QNH Sources

Where the forecast area QNH is used, the minima used must be increased by 50 FT.

*(TERMINAL AU30)*

### 4.4.4 Precision Approach Radar (PAR)

Precision Approach Radar is a standard instrument approach procedure in which an electronic glide path is provided.

The PAR approach is a precision instrument approach wherein the air traffic controller issues guidance instructions, for pilot compliance, based on the aircraft's position in relation to the final approach course (azimuth), the glide path (elevation), and the distance (range) from the touchdown point.

### 4.4.5 GBAS-Landing System (GIS)

The GLS approach is a system for approach and landing operations utilising GNSS, augmented by a Ground-Based Augmentation System (GBAS), as the primary navigational reference.

A GLS currently supports precision approach operations with minima as low as CAT I, but with the future potential for supporting CAT II and III operations.

A GLS consists of a GBAS ground station located on or in the vicinity of one or more airports and an aircraft subsystem. The GBAS provides data and corrections for the GNSS ranging signals over a digital VHF data broadcast to the aircraft subsystem. The aircraft subsystem translates the position signal into flight guidance similar to that provided for an ILS.

If GBAS fails, GLS approaches are not available.

The altimeter checks and flight tolerances are as per the ILS.

### 4.4.6 Categories of ILS

**Cat. I** Minimum altitude [DH] 200 FT

Minimum visibility 800 M, 1200 M if no HIRL, 1500 M if no HIALS

**Cat. II** Minimum height [DH] 100 FT,

Minimum runway visual range [RVR] 350 M

**Cat. III** Cat.IIIA: Minimum height [DH] 100 FT. Minimum RVR 200 M

Cat. IIIB: Minimum DH lower than 15 M or no DH. Min. RVR 50 M

Cat. IIIC: No DH and no RVR limitation (Autoland).

## 4.5 DME/GNSS Arrival Procedures

DME arrival procedures provide a method of en route descent by reference to a DME from the lowest safe altitude or above, to a minimum altitude at an aerodrome. Azimuth (track) guidance is required from a suitable radio-navigation aid, e.g. NDB or VOR.

A DME arrival procedure is designed as a series of descending steps on particular tracks or within a specified sector. Descent is not permitted until the aircraft is established within the appropriate sector or on the specified inbound track. Where the destination is inside controlled airspace, the DME steps are designed to keep the aircraft within controlled airspace.

If manoeuvring within a sector, the pilot must ensure that the aircraft is contained within the sector and the appropriate DME step. Manoeuvring within a sector after the final approach fix is prohibited.

The missed approach point for DME arrival procedures is the azimuth aid (NDB, VOR) associated with the procedure unless another point is specified on the appropriate chart.

*(TERMINAL AU9)*

## 4.6 Approach Segments

An instrument approach procedure may have five separate segments. They are the arrival, initial, intermediate, final and missed approach segments. In addition, an area for circling the aerodrome under visual conditions is also considered.

### 4.6.1 Arrival Segments

When necessary or where an operational advantage is obtained, arrival routes from the en route phase to a fix or facility used in the procedure are published. En route obstacle clearance criteria are applied to arrival routes. The arrival route normally ends at the initial approach fix and are generally described in the STAR format.

### 4.6.2 Initial Approach Segment

The initial approach segment commences at the initial approach fix (IAF), and ends at the intermediate fix (IF) where specified. In the initial approach, the aircraft has departed the en route structure and is manoeuvring to enter the intermediate approach segment. Aircraft speed and configuration will depend on the distance from the aerodrome, and descent required. The initial approach segment provides at least 300 M (984 FT) of obstacle clearance in the primary area.

### 4.6.3 Intermediate Approach Segment

This is the segment during which the aircraft speed and configuration should be adjusted to prepare the aircraft for final approach. For this reason the descent gradient is kept as shallow as possible. During the intermediate approach the obstacle clearance requirement reduces from 300 M (984 FT) to 150 M (492 FT) in the primary area, reducing laterally to zero at the outer edge of the secondary area.

### 4.6.4 Final Approach Segment

This is the segment in which alignment and descent for landing are made. Final approach may be made to a runway for a straight-in landing, or to an aerodrome for a visual manoeuvre.

### 4.6.5 Missed Approach

During the missed approach phase of the instrument approach procedure the pilot is faced with the demanding task of changing the aircraft configuration, attitude and altitude. For this reason the design of the missed approach has been kept as simple as possible.

### 4.6.6 Visual Manoeuvring (Circling) in the Vicinity of the Aerodrome

Visual manoeuvring (circling) is the term used to describe the visual phase of flight after completing an instrument approach, to bring an aircraft into position for landing on a runway which is not suitably located for straight-in approach.

## 4.7 Instrument Approaches General

Unlike the DME arrival procedure which provides descent en route, an instrument approach procedure is a more cumbersome series of manoeuvres which provide descent after the aircraft has arrived overhead the destination navaid.

A strict set of operating restrictions apply to all instrument approach procedures. A thorough understanding of these restrictions is essential.

In the following paragraphs we will be studying the basic operating rules for instrument approaches. All of this information is contained in JEPPESEN TERMINAL.

## 4.8 Aircraft Performance Category

For the purpose of instrument approaches, all aircraft are categorized according to speed based on 1.3 times the stalling speed at maximum landing weight, in the landing configuration. An aircraft must fit into one category only. *(TERMINAL AU15)*

### 4.8.1 Category

A ..... Speed less than 91 KT IAS.

B ..... Speed between 91 KT and 120 KT IAS.

C ..... Speed between 121 KT and 140 KT IAS.

D ..... Speed between 141 KT and 165 KT IAS.

E ..... Speed between 166 KT and 210 KT IAS.

### 4.8.2 Speed for Procedure in Knots IAS

The speed restrictions which apply according to aircraft category and approach segment are:

| Aircraft Category | Range of speeds for initial and intermediate approach | Range of speeds for final approach | Max. speeds for visual manoeuvring (Circling) | Max. speeds for missed approach |
|---|---|---|---|---|
| A | 90–150 | 70–100 | 100 | 110 |
| B | 120–180 | 85–130 | 135 | 150 |
| C | 160–240 | 115–160 | 180 | 240 |

### 4.8.3 Approach

An instrument approach procedure can be broken into four separate parts, each part having a unique function. These parts are:

- Entry and holding procedures: faint lines on approach charts
- Approach procedures: bold lines on approach charts
- Visual manoeuvres: not depicted on approach charts
- Missed approach procedures: dashed lines on approach charts.

The entry and holding procedure is designed to provide a safe area for an aircraft to descend from lowest safe altitude to the approach commencement altitude, and to achieve alignment with the approach procedure. Speed restrictions apply to this approach segment.

The approach procedure provides a safe path for descent from the approach commencement altitude to the minimum descent altitude. Aircraft must be within +/-5 degrees for NDB; and +/- 1/2 scale for VOR/ILS/LLZ of the final approach track before descent can be commenced.

Visual manoeuvres will be required at the conclusion of a successful aerodrome instrument approach to accomplish final runway alignment. The extent of these manoeuvres will depend largely on the runway direction and runway in use.

The missed approach segment provides a safe climb path to follow should the approach be unsuccessful.

### 4.8.4 Timing

Times shown on outbound legs of holding and approach procedures provide for optimum manoeuvring in nil wind conditions. These times should be adjusted only to the extent that allows for the effects of a known wind component.

### 4.8.5 Holding Patterns General

When holding is required in a specified pattern, the procedures set out in *JEPPESEN TERMINAL-HOLDING PROCEDURES (AU5)*, must be followed.

Right turns holding patterns are standard holding patterns and must be followed unless the chart depicts, or ATC directs otherwise.

Holding patterns are also depicted on *JEPPESEN EN ROUTE (ERC)* and *JEPPESEN AREA charts*

The entry and holding procedures limitations are:

- Indicated airspeed shall not exceed 230 knots (170 KT where approach is limited to Cat A and B aircraft only) up to and including FL 140. 240 KT above FL 140.
- The outbound leg shall be no longer than:
  - Up to and including FL 140: 1 minute or the limit specified in the chart
  - Above FL 140: 1.5 minutes or the time limit specified in the chart.
- All turns in nil wind are to be at an angle of bank of 25° or at a rate of 3° per second (rate one), whichever requires the lesser angle of bank.
- Outbound timing begins abeam the fix, or when the outbound heading is attained, whichever occurs later.
- Allowance for the effects of known wind should be made in both heading and timing to ensure the inbound track is regained before passing the holding fix inbound.

### 4.8.6 Descent Limitations

Except when conforming to a visual approach, prescribed DME arrival procedure, or when under radar control, an aircraft approaching an aerodrome shall not descend below the lowest safe altitude or minimum safe altitude for the route sector being flown until it arrives over the initial approach facility or fix. Having arrived over the initial approach facility or fix, further descent may be made as necessary in accordance with the entry and holding procedures and subsequently in accordance with the approved instrument approach procedure. *(TERMINAL)*

### 4.8.7 Approach Procedures

An aircraft that is not required to hold or lose height in a holding pattern may commence the outbound leg of the reversal procedure without entering the holding pattern if the initial approach track is within a 60° sector, 30° on either side of:

- The outbound leg of the reversal procedure of the instrument approach
- The inbound holding track, where a procedure turn shown on the approach chart must be completed prior to commencing descent.

Outside controlled airspace, and within 25 miles of the initial approach facility or fix, an aircraft whose initial approach track is outside the 60° sector may diverge to intercept a track within this 60° sector, providing the aircraft is at an altitude not below the appropriate minimum safe altitude. *(TERMINAL AU19 APPROACH PORCEDURES, ATC AU 701 DEPARTURE, APPROACH AND LANDING PROCEDURES)*

An aircraft may commence a segment in excess of the specified commencement altitude provided that the rate of descent during the final approach does not exceed 1000 ft per minute *(TERMINAL AU22)* All altitudes shown on profile diagrams are descent limitations.

### 4.8.8 Multi-Engine Performance

Most multi engine aircraft lose 80% of normal climb performance with loss of one engine.

The loss of one engine means that such an aircraft will not achieve a minimum 2.5% obstacle Climb Gradient.

What does 2.5% mean to a pilot?

2.5% = a climb of 2.5 feet per 100 feet travelled over the ground.

This is equivalent to 25 feet climb over a distance of 1000 feet

Given that 1nm equals approximately 6000 feet it can be determined that 2.5% will provide a climb of approximately 150 feet.

Reference the *JEPPESEN TERMINAL*, *Gradient to Rate Table* for any given Ground speed.

The pilot is able to monitor the progress of the climb by consulting the gradient to rate table pre-departure. Based on an expected rate of climb, the pilot can form an ‘escape plan’ if actual climb performance does not meet the required planned performance. This is true during both the arrival and departure phases of flight.

Consider the CANBERRA, ACT, NDB approach.

Beechcraft Duchess 76 aircraft

CLIMB - one engine inoperative

Climb speed 85 KT. Aircraft weight 3800 lb, pressure altitude 4000'

ISA conditions, rate of climb [ROC] = 140 FT/min.

CBR aerodrome MDA = 3250'.

Missed Approach Safe Altitude = 5100'.

Therefore from the minima we must climb 1850' to reach the missed approach altitude.

Determine the new MDA required maintaining obstacle clearance given a 10 KT head wind component.

GS = 75 KT. ROC 140'/min. [gradient = ROC / GS]

Therefore gradient possible = 1.86%.

Gradient required 2.5%

Now calculate the altitude gain possible using the Jeppesen Flight Computer.

(Place 1.86 on the outside scale over 2.5 on the inside scale and read the answer on the outside scale over 1850 on the inside scale)

The answer is 1375', we will use 1370'.

Now subtract 1370' from 1850' = 480'.This amount must be added to the MDA. New MDA is [3250' + 480'] = 3730'.

In other words, if conducting a One Engine Inoperative NDB approach at CANBERRA, you will be committed to land if you descend below 3730 ft.

If the weather forecast indicates visual reference below 3730 ft, then there is no problem with terrain clearance. If there is any doubt then you must consider the 100ft missed approach obstacle clearance of 2.5 %. *(TERMINAL AU23)*

### 4.8.9 Approach Termination

An aircraft approaching an aerodrome for the purpose of landing, need not commence or may discontinue an approved instrument approach procedure when:

- By **DAY**, within 30 miles of the destination at an altitude not below the LSALT/MSA for the route segment being flown, the appropriate step of a DME arrival procedure or the minimum descent altitude for the procedure being flown, the aircraft is established:
  - Clear of cloud
  - In sight of the ground or water
  - With a flight visibility of not less than 5000 metres **or** the aerodrome is in sight
  - Subsequently can maintain the above mentioned at an altitude compatible with VFR flight [CAR 157] to within the prescribed circling area of that aerodrome.
- By **NIGHT**, the aircraft is established:
  - Clear of cloud
  - In sight of ground or water
  - With a flight visibility not less than 5000 M
  - Within the circling area *(Non-instrument-procedure destination: AIR TRAFFIC CONTROL AU601)*
  - Within 5 NM [7 NM for a runway equipped with an ILS] of that aerodrome aligned with the runway centreline and established not below "on slope" on the T-VASIS or PAPI
  - Within 10 NM (14 NM for runways 16L and 34R at Sydney Intl.) of that aerodrome, established not below the ILS glide path with less than full scale azimuth deflection. *(TERMINAL AU26)*

When visual reference has been established within the circling area at or above the MDA, further descent below MDA may only occur when the pilot:

- Maintains the aircraft within the circling area (a)
- Maintains a visibility along the intended flight path not less than the minimum specified for the procedure (b)
- Maintains visual contact with the landing runway environment (i.e., the runway threshold or approach lighting or other markings identifiable with the runway) and either:
  - o By **night or day**, while complying with the above (at an altitude not less than the MDA), intercepts a position on the downwind, base or final leg of the landing traffic pattern, and, from this position, can complete a continuous descent to the landing threshold, and, maintains obstacle

clearance along the flight path not less than the minimum for the aircraft performance category until the aircraft is aligned with the landing runway.

- o In **daylight only**, while complying with the above maintains visual contact with obstacles along the intended flight path and an obstacle clearance not less than the minimum for the aircraft performance category until the aircraft is aligned with the landing runway.

An aircraft shall not land or continue an approach below the approved minimum descent altitude at any aerodrome when any element constituting the meteorological minima is less than that prescribed for that aerodrome and the particular operation.

**RESTRICTIONS ON VISUAL CIRCLING**

Visual circling is prohibited in 'no circling' sectors by day in less than VMC and always at night.

### 4.8.10 Missed Approach Procedures

A missed approach shall be executed if:

- Visual reference is not established at or before reaching the prescribed point or altitude from which the missed approach commences.
- An aircraft which is conducting an instrument approach procedure and establishes visual reference should subsequently lose visual reference while at or below the minimum altitude.
- A landing straight ahead cannot be effected from a straight-in approach, unless a circuit can be in weather conditions equal to or better than those specified for circling.
- During an instrument approach and below the minimum safe altitude, the performance of the radio aid becomes suspect or the radio aid fails.

The missed approach segment of an instrument approach is designed to provide a minimum of 100 feet obstacle clearance to an aircraft climbing at 2.5% (152 FT/NM).

It is important to ensure that your aircraft is capable of achieving this climb gradient, particularly in the early stages of a single engine go-around (multi-engine aircraft only).

JEPPESEN TERMINAL page 7 provides a gradient rate table to assist pilots determine climb rates required to achieve various climb gradients at different stages.

A rule of thumb for determining the minimum rate of climb required for a 2.5% climb gradient is to divide climbing indicated airspeed by 60 and multiply the result by 152.

e.g. CLIAS 90 KT (90 ÷ 60) x 152 = 228 FT/MIN)

Note: Climb ground speed gives a more accurate figure, but is seldom known.

*(TERMINAL AU23)*