CRITERIA FOR THE DEVELOPMENT OF INSTRUMENT PROCEDURES

TP 308 / GPH 209 – CHANGE 7

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FORWARD

This publication prescribes standardized methods for use in designing instrument flight procedures. It is to be used by personnel charged with the responsibility for the preparation, approval and promulgation of instrument procedures. Compliance with criteria contained herein is not a substitute for sound judgment and common sense. These criteria do not relieve procedure designers and supervisory personnel from exercising initiative or taking appropriate action in recognizing both the capabilities and limitations of aircraft and navigational aid performance. These criteria are predicated on normal aircraft operations for considering obstacle clearance requirements.

Obstacle clearance is the primary safety consideration in the development of instrument procedures. Obstruction clearances quoted in this publication are the lowest or smallest values that can be accepted consistent with flight safety.

In the event of a conflict or disaccord between English and French versions of this criteria, the English version is considered the authority.

Recommendations concerning changes or additions should be provided to one of the following:

**Department of National Defense (DND)**
Division Instrument Check Pilot (DICP)  
1 Canadian Air Division Headquarters  
PO Box 17000  
Station Forces  
Winnipeg, MB  R3J 3Y5

**Transport Canada**
Chief of Standards (AARTA)  
Aerodromes and Air Navigation  
Place de Ville, Tower "C",  
330 Sparks St.  
Ottawa, ON  K1A 0N5
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EXPLANATION OF CHANGES

Change 7 to the *Criteria for the Development of Instrument Procedures* (TP308/GPH209) introduces new instrument procedure design criteria for Performance Based Navigation (PBN).

Following the lead of the US Federal Aviation Administration (FAA), all of FAA 8260.58 Performance Based Navigation (PBN) and partial FAA 8260.42B United States Standard for Helicopter Area Navigation (RNAV) are now integrated into TP308/GPH209 Volume 2 – Performance Based Navigation (PBN).

CARs 803.02(b) states that no person shall publish or submit for publishing in the Canada Air Pilot an instrument procedure unless the procedure has been developed by a person who has successfully completed training in the interpretation and application of the standards and criteria specified in the manual entitled Criteria for the Development of Instrument Procedures, which training has been accepted by the Minister.

The volume and chapter numbers are identified on the inside top right corner of the page. The chapter and page numbers (example 1-1) are on the bottom centre of the page. The revision number (Change 7.0) is on the bottom left corner and the date of issue is bottom right. The vertical change lines located outside of the left border indicate modifications or corrections made from TP308/GPH 209 Change 6.0. The change lines were not added to the new Volume 2, Annex F and Vol 1/3 Alphabetical Index.

For administrative purposes, most table and figure numbers have continued to be revised to be compatible with the FAA’s Terminal Instrument Procedures Criteria (TERPs). Most tables and diagrams for each chapter remain at or near the text where they are first mentioned.

Training requirements for criteria in adherence to CARs 803.02 is contained in the AC announcing the implementation of a change to the Criteria for the Development of Instrument Procedures (TP308/GPH209).

TP308/GPH209 will be amended as required. Updates and notices will be posted via AC, at: [https://www.tc.gc.ca/eng/civilaviation/opssvs/managementservices-referencecentre-acs-800-menu-512.htm](https://www.tc.gc.ca/eng/civilaviation/opssvs/managementservices-referencecentre-acs-800-menu-512.htm)

ADVISORY CIRCULARS

Publication of Change 7 supersedes the following TP 308/GPH 209 ACs:


The following TP 308/GPH 209 AC remains in effect:


EFFECTIVE DATE

5 January 2017.
Significant areas of new direction, guidance, and policy included in this change are as follows:

**Volume 1, General Criteria**

(1) **Chapter 1 – Administration**

(a) Para 104. Existing Procedures – Revised;
(b) Para 109. Heliport Geometric Centre (HGC)/Aerodrome Geometric Centre (AGC) – Added;
(c) Para 120. Procedure Development Requirements – Revised;
(d) Para 120. Supplementary Note – Added;
(e) Para 131. Establish And Revise Instrument Procedures – Revised;
(f) Para 132. Periodic Review – Added;
(g) Para 141. Non-Standard Procedures – Revised;
(h) Para 150a. Military Aerodromes – Revised; and
(i) Para 150b. Civil Aerodromes – Revised.

(2) **Chapter 2 – General Criteria**

(a) Figure 2-1a. Note – Revoked;
(b) Para 203. Sloping Obstacle Clearance Surfaces (OCS) – Revised;
(c) Para 203. (Two) Supplementary Note – Added;
(d) Figure 2-1-3. Climb Segment – Revised;
(e) Para 210. Units of Measurement – Revised;
(f) Para 216. Controlling Obstacle(s) – Added;
(g) Para 216. Supplementary Note – Added;
(h) Para 217. Obstacle Height Assessments – Revised;
(i) Para 218-219. Reserved – Revised;
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(k) Para 232a. Alignment – Revised;
(l) Formula 2-1. Distance Flown Along Arc, Distance to lead Radial/Bearing. Para 232a. – Revised;
(m) Para 232c. Obstacle Clearance – Revised;
(n) Para 232d. Descent Gradient – Distances Revised;
(o) Figure 2-3. Initial approach intersection angle > than 90 – Revised;
(p) Para 233. Obstacle Clearance – Revised;
(q) Figure 2-4-1. Most Common DR Segment – Revised;
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(v) Para 234. Initial Approach Segment Based On A Procedure Turn (PT) – Revised;
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(x) Para 235. Initial Approach Based On High Altitude Teardrop Penetration – Revised;
(y) Figure 2-6a: Obstacle Clearance Areas. Paras 234.c and 235.c. – Revised;
(z) Para 234. Initial Approach Segment Based On A Procedure Turn (PT) – Revised;
(aa) Figure 2-9-2. Example of Initial Course Reversal – Revised;
(bb) Figure 2-9-3. Note – Added;
(cc) Para 242. Obstacle Clearance – Revised;
(dd) Para 242. Supplementary Note – Added;
(ff) Para 252. Descent Angle/Gradient – Revised;
(gg) Figure 2-14-9. Final Length Given FAF Altitude – Revised;
(hh) Figure 2-14-11. FAF Net Given Segment Length – Renamed;
(ii) Figure 2-14-11. FAF Net Given Segment Length – Values Revised;
(jj) Para 276. Turning Missed Approach Obstacle Clearance – Revised;
(kk) Para 277. Combination Straight And Turning Missed Approach Area – Revised;
(ll) Para 279. Missed Approach Climb Gradient – Added;
(mm) Figure 2-29. Intermediate Or Initial Approach Fix Errors – Revised;
(nn) Figure 2-29. Note – Added;
(oo) Para 288. Supplementary Note – Added;
(pp) Para 289. Obstacles Close To a FAF or SDF – Revised;
(qq) Para 289. Supplementary Note – Added;
(rr) Figure 2-36a: Obstacle Close-In To A Fix Para 289 – Revised;
(ss) Figure 2-36b. Example Of Obstacle Close In To Fix – Revised; and
(tt) Figure 2-36c. 7:1 Slope Worksheet (Example) – Revised.

(3) **Chapter 3 – Take-Off and Landing Minima**

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(b) Figure 3-37c. Elevation Differential Area (EDA) – Revised;
(c) Table 3-1. Standard Straight-in And Circling Minima – Revised;
(d) Table 3-2. Non-Precision Minima Visibility Matrix. – Revised; and
(e) Table 3-5. Minimum HAT for PA and APV – Renamed.
(4) Chapter 4 – On-Airport VOR (No FAF)
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(6) Chapter 6 – NDB PROCEDURE ON-AIRPORT FACILITY, NO FAF
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   (c) Figure 6-57a. Secondary ROC – Revised.

(7) Chapter 7 – NDB WITH FAF
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   (b) Table 7-15. Minimum Length of Final Approach Segment – NDB (NM) – Formatting; and
   (c) Figure 7-66a: Minimum Obstacle Clearance – Revised.

(8) Chapter 8 – EMERGENCY VHF/UHF DF PROCEDURES
   (a) Para 811b. Obstacle Clearance – Revised;
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(9) Chapter 9 – LOCALIZER
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(10) Chapter 12 – DEPARTURE PROCEDURE
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   (h) Para 1211. Establishment of Altitude For Visual Climb Area – Revised;
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(11) **Chapter 17 – EN ROUTE CRITERIA**

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(b) Para 1721. Obstacle Clearance, Secondary Areas – Revised;
(c) Figure 17-9. Airplane to drawing– Added;
(d) Figure 17-17. Cross Section, Secondary Area Obstacle Clearances – Revised;
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(f) Figure 17-19. Secondary Obstacle Clearance – Revised; and
(g) Figure 17-27. LF Segment Obstacle Clearance Area beyond 25 NM From Enroute Facility – Formatting.

(12) **Chapter 18 – HOLDING CRITERIA**

(a) Figure 18-3. DME Slant Range Distance – Revised; and
(b) Figure 18-9. Holding Template – Revised.

(13) **Alphabetical Index – Added**

**Volume 2, Performance Based Navigation (PBN) Construction**

(1) **Chapter 1 – PURPOSE** – Added;
(2) **Chapter 2 – BASIC CRITERIA INFORMATION** – Added;
(3) **Chapter 3 – GENERAL INFORMATION** – Added;
(4) **Chapter 4 – RNAV AND RNP DEPARTURE PROCEDURES** – Added;
(5) **Chapter 5 – TERMINAL ARRIVAL AREA (TAA) DESIGN** – Added;
(6) **Chapter 6 – STANDARD FOR REQUIRED NAVIGATION PERFORMANCE (RNP) APPROACH PROCEDURES WITH AUTHORIZATION REQUIRED (AR)** – Added;
(7) **Chapter 7 – AREA NAVIGATION (RNAV)** – Added;
(8) **Chapter 8 – STANDARD FOR HELICOPTER AREA NAVIGATION (RNAV)** – Added;
(9) **Appendix A. TERPS Standard Formulas for Geodetic Calculations** – Added; and
Appendix B. Initial Climb Area (ICA) Concept – Added.

Volume 3, Precision Approach (PA) & Baro VNAV Approach Procedure Construction

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(a) Para 2.6.1c. Supplementary Note – Added;
(b) Para 2.9 Determining PFAF/FAF Coordinates – Revised;
(c) Para 2.9.1 Distance Measuring Equipment (DME) – Revised;
(d) Para 2.9.1 Supplementary Note – Added;
(e) Para 2.11.1. Area – Revised;
(f) Figure 2-6 Category II Critical Areas – Reference Removed; and
(g) Formula 2-2b. GQS Half-Width at RWT – Renamed & Revised.

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(b) Para 3.8.1 GPI Distance – Renamed;
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(d) Para 3.9.1b. Section 1b. – Revised;
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(h) Figure 3.6 X OCS – Renamed;
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(f) Para 6.9.1 Section 1 – Revised.

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(1) NO CHANGE.
Volume 5, Helicopter Instrument Procedure Construction

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(b) Para 110. Descent Gradient – Revised;
(c) Para 111(a) Alignment – Revised;
(d) Para 112. Initial Approach Based On Procedure Turn – Revised;
(e) Para 114. Intermediate Approach Segment Based On An Arc – Revised;
(f) Para 126. Altitudes – Revised; and
(g) Para 127. Visibility – Revised.


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(2) Annex B – Minimum Vectoring Altitude
(a) NO CHANGE.

(3) Annex C – Procedures
(a) NO CHANGE.

(4) Annex D – Obstacle Limitation Surface (OLS) versus Obstacle Clearance Surfaces (OCS)
(a) NO CHANGE.

(5) Annex E – Terrain and Obstacle Data (TOD)
(a) NO CHANGE.

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TP 308 / GPH 209 – CHANGE 7

VOLUME 1

GENERAL CRITERIA

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CHAPTER 1. ADMINISTRATION

100. Purpose
This manual contains the criteria that shall be used to formulate, review, approve and publish instrument procedures within Canada.

101. ICAO Annexes
No person shall introduce new or modify existing aeronautical information included in the Integrated Aeronautical Information Package of Canada, except:

a. in accordance with the standards set out in Annexes 4 and 15 to the Convention; and
b. in accordance with the processes and procedures established by the provider of aeronautical information services to meet the standards of Annexes 4 and 15 to the Convention.

Where ICAO Annexes 4 & 15 refers to PANS-OPS Doc 8168, reference shall be made to the applicable section(s) of the Criteria for the Development of Instrument Procedures (TP308/GPH209).

102. Reserved

103. Cancellation
This document supersedes all previous editions of TC TP308/DND GPH209, Criteria for the Development of Instrument Procedures.

104. Existing Procedures
Existing procedures, when subject to periodic review, shall be assessed for changes to criteria to determine if action to revise the procedure is required. New procedures shall be developed in accordance with these standards and criteria.

105. Type of Procedure
For use in Table 1-1 third column “type of procedure”

a. Precision Approach (PA)
An approach based on a navigation system that provides positive course and vertical path guidance conforming to ILS, MLS or PAR system performance standards contained in ICAO Annex 10.

b. Non-Precision Approach (NPA)
An approach which provides final course or lateral guidance. No vertical guidance is provided on an NPA. Types include but are not limited to NDB, VOR, LOC and certain RNAV approaches (etc. LNAV, LP)

c. Approach Procedure with Vertical Guidance (APV)
Approach type with stabilized descent using vertical guidance. APVs are divided into two types, those that use vertical guidance provided by:

(1) Lateral Navigation / Vertical Navigation (LNAV/VNAV) a path derived by the Baro-altimeter and the flight management systems, and

(2) Localizer Performance with Vertical Guidance (LPV) where the vertical guidance is provided by the Wide Area Augmentation System (WAAS).
106. Operating Minima
For use with Table 1-1 first column “NAVAID / Approach System Capability”
Approach operations are classified based on the lowest designed operating minima as:
   a. Non precision: At or above 250 ft; and
   b. Precision: below 250 ft.
107. Types of Instrument Procedures
Criteria are provided for the following types of authorized instrument procedures
   a. Departure procedures
   b. Enroute procedures
   c. Holding procedures
   d. Arrival procedures
   e. Instrument approach procedures
108. Height Above Touchdown (HAT)/ Height Above Threshold (HATH)
Throughout this document all references to “HAT” should be interpreted to read “Height Above Touchdown/ Height Above Threshold “HAT/HATH” (as applicable)
109. Heliport Geometric Centre (HGC)/Aerodrome Geometric Centre (AGC)
For the purpose of this publication, all references to Heliport Reference Point (HRP) or Aerodrome Reference Point (ARP) within this document (or referenced by this document), is to be interpreted to mean Heliport Geometric Centre (HGC) or Aerodrome Geometric Centre (AGC) respectively, except as otherwise noted.
110—119. Reserved
120. Procedure Development Requirements

Prior to the publishing of any instrument procedure, the following associated minimum standards shall be met:

a. Aerodrome. Table 1-1 represents the type of instrument procedure, associated minima and application (public or restricted use) authorized for any combination of NAVAID/approach system capability versus the landing surface and applicable aerodrome design standards or aerodrome authorization. Table 1-1 does not apply to PINSA procedures or non-instrument Heliports.

b. Navigation Facility. All electronic and visual navigation facilities used shall meet the applicable standard and the requirements of flight inspection and calibration.

c. Obstruction Marking and Lighting. Buildings, structures and objects, including objects of natural growth shall be marked and lighted in accordance with CAR 621.19, Standards Obstruction Markings or DND CETO C-98-01 0-003/MG-004.

d. Altimeter Setting Source. All instrument approach procedures shall be predicated on the availability of an approved altimeter-setting source in accordance with CAR 804.01. See Para 323.c.

e. Communications. In controlled airspace air-to-ground communications with an ATS facility shall be available at the initial approach fix minimum altitude and at the missed approach clearance limit altitude. At lower altitudes communications shall be required where essential to the safe and efficient use of airspace. Air-to-ground communication normally consists of UHF or VHF radio, but other communications may be approved at locations that have a special need and capability.

f. Flight Check. All instrument approach procedures, departure procedures, airways and air routes shall be flight checked prior to approval and at least once within a 5 year period for existing procedures. Flight checks shall be conducted by a person who has successfully completed training in the interpretation and application of the criteria found in this publication. **Guidance material for Flight checks can be found in ICAO DOC 9906.**

121. Retention and Cancellation

Before an instrument procedure is cancelled, coordination with civil and military users shall be effected. Care shall be taken not to cancel procedures required by the military or required by air carrier operators at provisional or alternate airports. Military procedures shall be retained or cancelled as required by the appropriate military authority.

122—129. Reserved
130. **Responsibility**

a. **Military Aerodromes.** The DND shall establish and approve terminal instrument procedures for aerodromes under their jurisdiction and be responsible for the publication of these procedures.

b. **Civil Procedures at Military Aerodromes.** At those military aerodromes where a need for civil approach procedures is identified, the appropriate civil authority shall coordinate with the DND and the procedure sponsor, before any approval/ publication/ revision/ cancellation of such procedures.

c. **Civil Aerodromes.** The appropriate civil authority shall establish terminal instrument procedures for civil aerodromes in accordance with this publication and be responsible for the publication of these procedures.

d. **Military Procedures at Civil Aerodromes.** At those civil aerodromes where the DND has a special requirement for approach or departure procedures the DND shall formulate, coordinate with the appropriate civil authorities, approve and publish such procedures. The civil authority shall be informed prior to cancellation of any of these DND procedures.

131. **Establish And Revise Instrument Procedures**

DND or the appropriate civil authority shall establish or revise terminal instrument procedures when:

a. new facilities are installed;

b. changes to existing facilities necessitate a change to an approved procedure;

c. additional procedures are necessary;

d. new obstacles dictate revision of existing procedures.

e. an operational assessment dictates;

f. there is a change to standards or criteria that may affect flight safety; or

g. there is a change to airspace structure.

132. **Periodic Review**

All procedures shall be subjected to a periodic review. The maximum interval for this review is five years.

133—139. **Reserved**
### Certified Aerodromes

<table>
<thead>
<tr>
<th>NAVAID/ Approach System Capability</th>
<th>Landing Surface</th>
<th>Type of Procedure</th>
<th>Minima Authorized</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision</td>
<td>Precision</td>
<td>PA CAT I, II, III, NPA or APV</td>
<td>Applicable Minima</td>
<td>Public or Restricted</td>
</tr>
<tr>
<td>Precision</td>
<td>Non-Precision</td>
<td>PA, NPA or APV</td>
<td>250 feet HAA/HAT</td>
<td>Public or Restricted</td>
</tr>
<tr>
<td>Precision</td>
<td>Non-Instrument</td>
<td>PA, NPA or APV</td>
<td>500 feet HAA/HAT</td>
<td>Public or Restricted</td>
</tr>
<tr>
<td>Non-Precision</td>
<td>Precision</td>
<td>NPA or APV</td>
<td>250 feet HAA/HAT</td>
<td>Public or Restricted</td>
</tr>
<tr>
<td>Non-Precision</td>
<td>Non-Precision</td>
<td>NPA or APV</td>
<td>250 feet HAA/HAT</td>
<td>Public or Restricted</td>
</tr>
<tr>
<td>Non-Precision</td>
<td>Non-Instrument</td>
<td>NPA or APV</td>
<td>500 feet HAA/HAT</td>
<td>Public or Restricted</td>
</tr>
</tbody>
</table>

### Non-Certified Aerodromes

<table>
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<th>NAVAID/ Approach System Capability</th>
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<th>Type of Procedure</th>
<th>Minima Authorized</th>
<th>Application</th>
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<tr>
<td>Precision</td>
<td>Non-Precision</td>
<td>PA, NPA or APV</td>
<td>250 feet HAA/HAT</td>
<td>Restricted</td>
</tr>
<tr>
<td>Precision</td>
<td>Non-Instrument</td>
<td>PA, NPA or APV</td>
<td>500 feet HAA/HAT</td>
<td>Restricted</td>
</tr>
<tr>
<td>Non-Precision</td>
<td>Non-Precision</td>
<td>NPA or APV</td>
<td>250 feet HAA/HAT</td>
<td>Restricted</td>
</tr>
<tr>
<td>Non-Precision</td>
<td>Non-Instrument</td>
<td>NPA or APV</td>
<td>500 feet HAA/HAT</td>
<td>Restricted</td>
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</table>

### NAVAID/ Approach System Capability

<table>
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<th>Type of Procedure</th>
<th>Minima Authorized</th>
<th>Application</th>
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<td>Non-Precision</td>
<td>PA, NPA or APV</td>
<td>250 feet HAA/HAT</td>
<td>Public or Restricted</td>
</tr>
<tr>
<td>Precision</td>
<td>Non-Instrument</td>
<td>PA, NPA or APV</td>
<td>500 feet HAA/HAT</td>
<td>Public or Restricted</td>
</tr>
<tr>
<td>Non-Precision</td>
<td>Non-Precision</td>
<td>NPA or APV</td>
<td>250 feet HAA/HAT</td>
<td>Public or Restricted</td>
</tr>
<tr>
<td>Non-Precision</td>
<td>Non-Instrument</td>
<td>NPA or APV</td>
<td>500 feet HAA/HAT</td>
<td>Public or Restricted</td>
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</table>

### NAVAID/ Approach System Capability

<table>
<thead>
<tr>
<th>NAVAID/ Approach System Capability</th>
<th>No Aerodrome Status</th>
<th>Type of Procedure</th>
<th>Minima Authorized</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision, Non-Precision</td>
<td>Landing surface designed to no standards</td>
<td>PA, NPA or APV</td>
<td>500 feet HAA/HAT</td>
<td>Restricted</td>
</tr>
</tbody>
</table>

**Note:** (1) Operational note providing wingspan advisory information shall be published on the instrument procedure approach plate.

**Table 1-1:** Instrument Procedure & Minima Authorized Versus Aerodrome Status, Para 120.a.
140. Formulation

Procedures shall be prepared in accordance with this publication as determined by the types of navigation facility and procedure to be used. To permit use by aircraft with limited navigational equipment the complete procedure should be, whenever possible, formulated on the basis of a single navigation facility. However, the use of an additional facility in the procedure may be considered if its use would provide an operational advantage.

141. Non-Standard Procedures

The standards contained in this publication are based on reasonable assessment of the factors that contribute to flight technical errors in aircraft navigation and maneuvering, and errors in airborne and ground facility accuracy. They are designed primarily to assure the safety of all users. The dimensions of obstacle assessment areas are influenced by the need to provide for a smooth transition to and from the en route system. Every effort shall be made to formulate procedures in accordance with these standards and criteria; however, peculiarities of terrain, navigation information, obstacles, etc. may require special consideration. In such cases, Transport Canada or Department of National Defense (DND), as appropriate, may approve non-standard procedures provided the deviations are fully documented and an equivalent level of safety exists. A non-standard procedure is not a substandard procedure, but is one that has been approved after special study of the local problems has demonstrated that no degradation of safety is involved. These procedures must also include a cautionary note identifying the divergence from the standards or criteria.

142—149. Reserved
150. Coordination
It is necessary to coordinate terminal instrument procedures to protect the interests of all users of airspace.

a. Military Aerodromes. Military and/or civilian procedures at a military aerodrome shall be coordinated with the appropriate base authorities. When a military and/or civilian procedure conflicts with other military/civil activities it shall be coordinated with all appropriate authorities concerned. Coordination shall occur between the procedure sponsor, procedure designer, the appropriate military (DND) authorities and the appropriate civil AIS Authority.

b. Civil Aerodromes. Prior to establishing or revising terminal instrument procedures related to aircraft performance, e.g., descent profiles, the appropriate civil authority shall coordinate with the appropriate users as considered necessary. Coordination with DND is required when a military operating unit is based at a civil aerodrome or when the proximity of a military aerodrome may cause a procedural conflict. New or revised military procedures at civil aerodromes shall be coordinated by the appropriate Wing Instrument Check Pilot (WICP) and the civil AIS Authority. Complete coordination will be evidenced by the appropriate signatures being included in the Instrument Procedure Design File. Required signatures include the procedure designer, independent reviewer, flight check pilot, and applicable Air Traffic Services (ATS) representative.

c. Air Traffic Control. Prior to establishing or revising terminal instrument procedures for a military or civil aerodrome, the initiating office shall coordinate with the appropriate Air Traffic Control office.

d. Airspace Action. Where action to designate or restructure controlled airspace for a procedure is planned, such action shall be approved by Transport Canada AARTA and should be initiated sufficiently in advance so that effective dates of the procedure and the airspace action coincide. Effective dates should also coincide with approved AIRAC dates.

e. NOTAM. A NOTAM to change minimum altitudes may be issued in case of emergencies, i.e., facility outages, facility out of tolerance, new penetrations of critical surfaces, etc. However, a complete new procedure may not be issued by NOTAM, except where military requirements dictate.

151. Coordination Conflicts
Coordination conflicts amongst stakeholders that cannot be satisfactorily resolved by the AIS Authority shall be submitted to Transport Canada and/or the appropriate Military Aeronautical Authority for resolution.

152. – 159. Reserved
160. Identification of Procedures.

Instrument procedures shall be identified to be meaningful to the pilot, and to permit ready identification in ATC phraseology.

161. Straight-In Procedure Identification.

Instrument procedures that meet criteria for authorization of straight-in landing minima shall be identified by a prefix describing the navigational system providing the final approach guidance and the runway to which the final approach course is aligned:

a. General – The following items shall be included in procedure identification of straight-in procedures.
   (1) The acronym for the navigational system used for guidance on the final approach segment
   (2) The acronym “RWY” to denote a straight-in procedure
   (3) The runway number of the straight-in runway
   Example(s): VOR RWY 18R

b. Duplicate Procedures – When there is more than one separately published procedure using the same final approach guidance to the same runway, a duplicate procedure character shall be used to uniquely identify the approach procedures. This character shall begin with “Z” and proceed through the alphabet in reverse order.
   Example(s): ILS Z RWY 28L RNAV (GNSS) Z RWY 12
              ILS Y RWY 28L RNAV (RNP) Y RWY 12

c. Multiple Procedures – When procedures are combined on one chart, the word ‘or’ shall indicate that either type of equipment may be used to execute the final approach.
   Example(s): ILS or NDB RWY 02

d. DME Requirement – if DME is required for a VOR or NDB procedure, then a slash “/” followed by “DME” shall be included in the identification.
   Example(s): VOR/DME RWY 18 NDB/DME RWY 27L

e. Northern Domestic Airspace – When the procedure is within northern domestic airspace and the procedure tracks are specified in true degrees, the procedure identification may be suffixed with “(TRUE)”.
   Example(s): RNAV (GNSS) RWY 34 (TRUE)

f. Non-RNAV – Conventional procedures identification examples include:
   (1) Category 2 or 3 Instrument Landing System (ILS CAT II or III)
       ........................................................................................................... ILS CAT II or III RWY 05
   (2) Category 1 Instrument Landing System (ILS)........................................ ILS RWY 24R
   (3) Microwave Landing System (MLS)..................................................... MLS RWY 12
   (4) Localizer Only (LOC) .......................................................................... LOC RWY 06
   (5) Localizer Back Course (LOC(BC)) ..................................................... LOC (BC) RWY 18
   (6) VHF Omni Directional Range (VOR).................................................. VOR RWY 27
   (7) VOR with Distance Measuring Equipment (DME) ......................... VOR/DME RWY 27R
(8) Tactical Air Navigational Aid (TACAN) ................................................. TACAN RWY 09
(9) Non Directional Beacon (NDB)............................................................. NDB RWY 12
(10) NDB with DME.................................................................................. NDB/DME RWY 12

g. **RNAV** – Area Navigation (RNAV) procedures identification examples include:
   (1) RNAV based on the Global Navigation Satellite System (GNSS)
       ........................................................................................................... RNAV (GNSS) RWY 12
   (2) RNAV based on Required Navigational Performance (RNP)
       ........................................................................................................... RNAV (RNP) RWY 29R
   (3) Ground Based Augmentation System (GBAS) Landing System (GLS)
       ........................................................................................................... GLS RWY 06

162. **Circling Procedure Identification.**

Instrument procedures which do not meet criteria for authorization of straight-in landing minima shall be identified by a prefix describing the navigational system providing the final approach guidance and an alphabetical suffix. The first procedure formulated shall bear the suffix “A” even though there may be no intention to formulate additional procedures. If additional procedures are formulated they shall be identified alphabetically in sequence. A revised procedure will bear its original identification.

   **Example(s):** RNAV (GNSS) A VOR B
   NDB/DME C (TRUE)

163. **Differentiation.**

Where high altitude procedures are required, the procedure identification shall be prefixed with the letters “HI”.

   **Example(s):** HI TACAN RWY 15.

164. – 169. **Reserved**
170. Submission
Instrument procedures shall be submitted as detailed by NAV CANADA.

a. DND procedures shall be submitted by the designer in accordance with GPH 209 and 1 Cdn Air Div Orders, Vol 2, 2-009, instruction for Developing and Revising Instrument Procedures. A proper and complete submission shall include copies of all maps and calculations used in the development of the procedure and a sufficient number of copies of the completed draft to provide all intermediate agencies with at least one copy.

b. Civil procedures (public or restricted) shall be submitted in accordance with NAV CANADA process and procedures.

c. When a procedure is submitted it shall show the name and signature of the Designer, Independent Reviewer, Flight Check Pilot, and the individual responsible for ATS coordination.

171. Issuance

a. DND is responsible for the release of military approved instrument procedures.

b. NAV CANADA is responsible for the release and distribution of all other instrument procedures.

172. Effective Date
Instrument procedures and revisions thereto shall be processed in sufficient time to permit publication and distribution in advance of the effective ICAO, Aeronautical Information Regulation and Control (AIRAC) date. Effective dates should normally coincide with scheduled airspace changes except when safety or operational effectiveness is jeopardized. In this case the originator shall specify an appropriate effective date.

173—179. Reserved
180. **TP308/GPH209 Amendment Procedures**

Amendments to TP308/GPH209 should normally be produced once per year. Bases/Agencies may submit amendment proposals to DICP/Transport Canada AARTA at anytime. DICP and Transport Canada AARTA staffs shall meet to review proposals for incorporation as appropriate. DND/TC Aviation will liaise with the DOD/FAA regarding U.S. TERPS.

181. **Amendment Printing/Distribution**

DICP and TC AARTA shall incorporate the adopted amendments into TP308/GPH209. Transport Canada AARTA shall prepare the amendment directive and coordinate the publishing requirements.

182—199. **Reserved**
CHAPTER 2. GENERAL CRITERIA

200. Scope

This chapter contains only that information common to all types of terminal instrument procedures. Criteria that do not have general application are located in the individual chapters concerned with the specific types of facilities.

SECTION 1. COMMON INFORMATION

201. TP308/GPH209 Criteria

a. TP308/GPH209 specifies the minimum measure of obstacle clearance that is considered by Transport Canada, to supply a satisfactory level of vertical protection. The validity of the protection is dependent, in part, on assumed aircraft performance. In the case of TP308/GPH209, it is assumed that aircraft will perform within certification requirements.

b. The following is an excerpt from the foreword of this document: "These criteria are predicated on normal aircraft operations for considering obstacle clearance requirements." Normal aircraft operation means all aircraft systems are functioning normally, all required navigational aids (NAVAID's) are performing within flight inspection parameters, and the pilot is conducting operations utilizing instrument procedures based on TP308/GPH209 standards to provide the required obstacle clearance (ROC). While the application of TP308/GPH209 criteria indirectly addresses issues of flyability and efficient use of NAVAID's, the major safety contribution is the provision of obstacle clearance standards. This facet of TP308/GPH209 allows aeronautical navigation in instrument meteorological conditions (IMC) without fear of collision with unseen obstacles. ROC is provided through application of level and sloping Obstacle Clearance Surfaces (OCS).

202. Level OCS.

The level OCS concept is applicable to “level flight” segments. These segments are level flight operations intended for en route, initial, intermediate segments, and non-precision final approaches. A single ROC value is applied over the length of the segment. These values were determined through testing and observation of aircraft and pilot performance in various flight conditions. Typical ROC values are: for en route procedure segments, 1,000 feet (1,500 or 2,000 over mountainous terrain), as designated in TP1820 - Designated Airspace Handbook; and for initial segments, 1,000 feet, 500 feet in intermediate segments, and 350/300/250 feet in final segments.

a. This method of applying ROC results in a horizontal band of airspace that cannot be penetrated by obstacles. Since obstacles always extend upward from the ground, the bottom surface of the ROC band is mathematically placed on top of the highest obstacle within the segment. The depth (ROC value) of the band is added to the obstacle height to determine the minimum altitude authorized for the segment. The bottom surface of the ROC band is referred to as the level OCS. Therefore, level flight segments are evaluated by the level OCS application standard (see Figure 2-1-1).
Figure 2-1-1: Minimum Segment Altitude. Para 202.a.

Figure 2-1a: Slope Ratio. Para 203.

Figure 2-1-2: Precision Glide Path Descent. Para 203.a.
203. Sloping Obstacle Clearance Surfaces (OCS).

The method of applying ROC, in segments dedicated to descending on a glidepath or climbing in a departure or missed approach segment, requires a different obstacle clearance concept than the level OCS because the ROC value must vary throughout the segment. The value of ROC near the runway is relatively small, and the value at the opposite end of the segment is sufficient to satisfy one of the level surface standards as per Para 202. It follows then, that a sloping OCS is a more appropriate method of ROC application.

Supplementary Note: Slope ratios are normally expressed in terms of rise over run in engineering and professional technical jargon. However, TP308/GPH209 has traditionally expressed slope ratios in terms of run over rise; e.g., 34:1, 40:1 (see Figure 2-1a).

a. Descending on a Precision Glidepath. The obstacle evaluation method for descent on a glidepath is the application of a descending OCS below the glidepath. The vertical distance between the glidepath and the OCS is ROC; i.e., ROC = (glidepath height) - (OCS height). The ROC decreases with distance from the FAF as the OCS and glidepath converge on the approach surface baseline (ASBL) height (see Figure 2-1-2). The OCS slope and glidepath angle values are interdependent: OCS Slope = 102 ÷ glidepath angle; or glidepath angle = 102 ÷ OCS slope. This relationship is the standard that determines the ROC value since ROC = (glidepath height) - (OCS height).

(1) If the OCS is penetrated, the OCS slope may be adjusted upward, thereby increasing the glidepath angle. The glidepath angle would increase because it is dependent on the required slope.

(2) Descent on a glidepath generated by systems that do not meet the system precision requirements of ICAO Annex 10, such as barometric vertical navigation (BARO-VNAV), provide ROC through application of a descending sloping surface based on standards using differing formulas, but the concept is the same.

b. Climbing on departure or missed approach. The concept of providing obstacle clearance in the climb segment, in instrument procedures, is based on the aircraft maintaining a minimum climb gradient. The climb gradient must be sufficient to increase obstacle clearance along the flightpath so that the minimum ROC for the subsequent segment is achieved prior to leaving the climb segment (see Figure 2-1-3). For TP308/GPH209 purposes, the MINIMUM climb gradient that will provide adequate ROC in the climb segment is 200 ft/NM (400 ft/NM for COPTER procedures) unless a higher gradient is specified.

(1) The obstacle evaluation method for a climb segment is the application of a rising OCS below the minimum climbing flightpath. Whether the climb is for departure or missed approach is immaterial. The vertical distance between the climbing flightpath and the OCS is ROC. ROC for a climbing segment is defined as ROC = 0.24CG. This concept is often called the 24% rule. Altitude gained is dependent on climb gradient (CG) expressed in feet per NM. The minimum ROC supplied by the 200 ft/NM CG is 48 ft/NM (0.24 x 200 = 48). Since 48 of the 200 feet gained in 1 NM is ROC, the OCS height at that point must be 152 feet (200 – 48 = 152), or 76% of the CG (152 ÷ 200 = 0.76). The slope of a surface that rises 152 over 1 NM is 40 (6076.11548 ÷ 152 = 39.97 = 40).

(2) Where an obstruction penetrates the OCS, a climb gradient in excess of 200 feet/NM (400 feet/NM for COPTER procedures) is required to provide adequate ROC. Since the climb gradient will be greater than 200 ft/NM, ROC will be greater than 48 ft/NM (0.24 x CG > 200 = ROC > 48). The ROC expressed in ft/NM can be calculated using the
formula: \( \frac{0.24h}{0.76d} \) where "h" is the height of the obstacle above the altitude from which the climb is initiated, and "d" is the distance in NM from the initiation of climb to the obstacle. Normally, instead of calculating the ROC value, the required climb gradient is calculated directly using the formula: \( \frac{h}{0.76d} \). Refer to Volume 2 for PBN climb gradient calculations.

**Supplementary note:** Military Option Climb Gradient for departure and missed approach will provide 48 ft of ROC for each NM of the flight path.

c. In the case of an instrument departure, the OCS is applied during the climb until at least the minimum en route value of ROC is attained. The OCS begins at the departure end of runway, at the elevation of the runway end. It is assumed aircraft will cross the departure end-of-runway at a height of at least 35 feet. However, for TP308/GPH209 purposes, aircraft are assumed to lift off at the runway end (unless the procedures state otherwise). The ROC value is zero at the runway end, and increases along the departure route until the appropriate ROC value is attained to allow en route flight to commence.

d. In the case of a missed approach procedure, the climbing flight path starts at the height of MDA or DA minus height loss. The OCS starts approximately at the MAP/DA point at an altitude of MDA/DA minus the final segment ROC and adjustments. Therefore, the final segment ROC is assured at the beginning of the OCS, and increases as the missed approach route progresses. The OCS is applied until at least the minimum initial or en route value of ROC is attained, as appropriate.

e. Extraordinary circumstances, such as a mechanical or electrical malfunction, may prevent an aircraft from achieving the 200 ft/NM minimum climb gradient assumed by TP308/GPH209. In these cases, adequate obstacle clearance may not be provided by published instrument procedures. Operational procedures contained outside TP308/GPH209 guidelines are required to cope with these abnormal scenarios.

204—209. Reserved
Figure 2-1-3: Climb Segment. Para 203.b.
210. Units Of Measurement

a. Bearings, Courses and Radials.
   (1) Bearings and courses shall be expressed in degrees magnetic, except that true and/or grid shall be used within the Northern Domestic Airspace;
   (2) Radials. VOR/TACAN radials shall normally be identified as the magnetic bearing FROM the facility and shall be prefixed with the letter "R" (e.g., R-130). When the facility is within the Northern Domestic Airspace and is oriented with grid (DND) or true north, radials shall be so indicated (e.g., R-130G, R-130T).

b. Altitudes. The unit of measure for altitude in this publication is feet
   (1) Published altitudes in the areas of the Altimeter Setting Region shall be expressed in feet above MSL, e.g. 17,900 feet. Published altitudes above the transition level (18,000 ft.) shall be expressed as flight levels (FL); e.g. FL190. Normally, altitudes at the transition level will not be used.
   (2) MSA, 100 Safe Altitude, TAA and Fix/WP up to the FAF, as well as the MA altitudes are rounded up to the next higher 100 foot increment;
   (3) All other altitudes expressed in the approach shall be rounded off to the next higher 20-foot increment, except the ILS glide path check altitude which shall be rounded off to the nearest 10-foot increment.
   (4) DA and DH values shall be rounded off to the next higher 1-foot increment.

c. Distances. Distances are to be expressed in nautical miles (6,076.11548 feet or 1852.0 meters per NM) and hundredths thereof, except:
   (1) Where feet are required,
   (2) Visitibilities are expressed in statute miles (5280 feet per SM) and fractions thereof; and
   (3) Runway Visual Range (RVR) is expressed in multiples of one hundred feet by increments of:
      (a) 200 feet from 600 feet to 3,000 feet; and
      (b) 500 feet from 3,000 feet to 6,000 feet.

Use the following formulas for feet and meter conversions:

\[
\text{feet} = \frac{\text{meters}}{0.3048} \quad \text{meters} = \text{feet} \times 0.3048
\]

d. Speeds. Aircraft speeds shall be expressed in knots indicated airspeed (KIAS).

211. Positive Course Guidance (PCG)

Positive course guidance shall be provided for feeder routes, initial (except as provided for in Para 233.b), intermediate, and final approach segments. The segments of a procedure wherein positive course guidance is provided should be within the service volume of the facility(ies) used. Positive course guidance may be provided by one or more of the navigation systems for which criteria has been published herein.
212. Aircraft Categories

Aircraft performance directly affects the amount of airspace and the visibility, which is required for maneuvering during instrument procedures. The varying performance is acknowledged by the following system of aircraft speed categories.

- **Category A** — speed less than 91 knots
- **Category B** — speed 91 knots or more but less than 121 knots
- **Category C** — speed 121 knots or more but less than 141 knots
- **Category D** — speed 141 knots or more but less than 166 knots
- **Category E** — speed 166 knots and greater

213. Aircraft Category Application

The approach category operating characteristics shall be used to determine turning radii, minimums, and obstacle clearance areas for circling, missed approach and certain departure procedures. When designing an instrument procedure, Category A, B, C and D normally will be considered for civil procedures and Category B, C, D and E will be considered for military procedures.

214. Procedure Construction

An instrument approach procedure (IAP) may have four separate segments. They are the initial, the intermediate, the final, and the missed approach segments. In addition, an area for circling the airport under visual conditions shall be considered. An approach segment begins and ends at the plotted position of the fix; however, under some circumstances certain segments may begin at specified points where no fixes are available. The fixes are named to coincide with the associated segment. For example, the intermediate segment begins at the intermediate fix (IF) and ends at the final approach fix (FAF). The order in which this chapter discusses the segments is the same order in which the pilot would fly them in a completed procedure; that is from an initial, through an intermediate, to a final approach. Only those segments that are required by local conditions need to be included in a procedure. In constructing the procedure, the final approach course (FAC) should be identified first because it is the least flexible and most critical of all the segments. When the final approach has been determined, the other segments should be blended with it to produce an orderly maneuvering pattern that is responsive to the local traffic flow. Consideration shall also be given to any accompanying controlled airspace to the extent it is feasible (see Figure 2-1-4).
215. Instrument Procedures And Class "F" Airspace

Instrument procedures may come in conflict with Class "F" airspace. Normally, the primary area obstacle clearance surface shall not penetrate the Class "F" airspace, however, instrument approach procedures may exist within Class "F" airspace when it is established for security reasons.

The vertical clearance from Class "F" airspace will vary depending upon the activity within the Class "F" airspace and the potential for conflict. The ROC for the instrument approach procedure segment overlying the Class "F" should be used as a guideline to establish obstacle clearance. In no case shall the ROC be less than 100 feet.

a. Where Class "F" restricted or advisory airspace has been established for military purposes or flight training activities, then the maximum ROC shall be applied.

b. Where Class "F" restricted airspace has been established for security reasons e.g. over a prison, the instrument procedure designer may elect to use a minimum of 100 feet of ROC.

c. Where Class "F" restricted airspace has been established for security reasons, e.g. visiting dignitaries, instrument procedures may exist within the Class "F", and authorization to fly the procedure may be given by the Controlling Agency.

d. For missed approach and departure procedures Class F airspace shall not penetrate the OCS.

Note: Where Class “F” airspace influences an instrument procedure, the type of activity within the Class “F” shall be documented, as well as the amount of ROC that has been applied. Other known areas that could constitute a hazard, such as known blasting areas, should be treated as Class “F” airspace and documented.

216. Controlling Obstacle(s)

The controlling obstacle in the segments of procedure shall be identified in the documentation submitted with the procedure. The minimum accuracy standards (Annex E) apply to all controlling obstacles. For sloping surface evaluations, the following standard shall be used to identify the controlling obstacles:

a. For PA and APV final segments, the controlling obstacle is that obstacle which, having penetrated the obstacle clearance surface requires the highest glide path angle (GPA) above 3 degrees and/or causes, the most adverse decision altitude (DA).

b. For missed approach segments, the controlling obstacle is that obstacle which, having penetrated the 40:1 OIS causes one of the following:

   (1) Highest DA/MDA;
   (2) Most adverse MAP relocation; or
   (3) Highest climb gradient and climb gradient termination altitude (may be different obstacles).

c. For departure areas, the controlling obstacle is that obstacle (or obstacles) which require the highest climb gradient and climb gradient termination altitude (may be different obstacles).
**Supplementary Note:** Obstacles that do not penetrate the sloping surface are not subject to the minimum accuracy standards and should not be called controlling obstacle.

**217. Obstacle Height Assessments**

When assessing contour lines on a topographical map to determine obstacle height, the accepted method is to use the contour that is on or in the trapezoid being assessed. To this figure, add the next contour interval MINUS one contour unit (foot/metre, as appropriate). If the area is treed, then the average tree height (determined from local forestry authorities) is added to the terrain elevation. A survey or a well-documented flight check process may confirm controlling obstacle elevations that are questionable.

In determining the height of mobile objects, the following standard shall be used:

a. 17.0 feet for mobile obstacles traversing multi-lane controlled access highways where over crossings are designed for a maximum of 17.0 feet vertical distance;

b. 15 feet for any other public roadway;

c. for a private roadway, 10 feet or the height of the highest mobile object, whichever is greater, that would normally traverse the road;

d. 23 feet for a railroad; and

e. for a waterway or any other traverse way not previously mentioned, an amount equal to the height of the highest mobile object that would normally traverse it.

**218—219. Reserved**
Figure 2-1-4: Segments Of An Approach Procedure. Para 214.
SECTION 2. EN ROUTE OPERATIONS

220. Feeder Routes

When the Initial Approach Fix (IAF) is part of the en route structure, there may be no need to designate additional routes for aircraft to proceed to the IAF. In some cases, however, it is necessary to designate feeder routes from the en route structure to the IAF. Only those feeder routes, which provide an operational advantage, shall be established and published. These should coincide with the local air traffic flow. The length of the feeder route shall not exceed the operational service volume of the facilities that provide navigational guidance, unless additional frequency protection is provided. En route airway obstacle clearance criteria normally apply to feeder routes, however feeder routes that are 25 NM or less may have 1,000 feet ROC applied. Feeder routes greater than 25 NM shall have en route airway obstacle clearance (Chapter 17) criteria applied. The minimum altitude established on feeder routes shall not be less than the altitude established at the IAF.

a. Construction of a feeder route connecting to a course reversal segment. The area considered for obstacle evaluation is oriented along the feeder route at a width appropriate to the type of route (VOR or NDB). The area terminates at the course reversal fix, and is defined by a line perpendicular to the feeder course through the course reversal fix.

b. The angle of intersection between the feeder route course and the next straight segment (feeder/initial) course shall not exceed 120°.

Descent Gradient. The OPTIMUM descent gradient of the feeder route is 250 feet per NM. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per NM. The OPTIMUM descent gradient for high altitude penetrations is 800 feet per NM. Where a higher descent gradient is necessary, the MAXIMUM permissible is 1000 feet per NM.
221. Safe Altitude/Minimum Sector Altitude (MSA)

A minimum safe altitude is the minimum altitude which provides at least 1,000 feet of obstacle clearance for emergency use, within a specified distance from the RNAV WP/primary navigation facility upon which a procedure is predicated or the aerodrome geographic centre (safe altitude 100 NM). These altitudes shall be rounded to the next higher 100-foot increment. Such altitudes will be identified as minimum sector altitudes or safe altitudes and shall be established as follows:

a. Minimum Sector Altitude (MSA). Establish an MSA for all procedures within a 25-mile radius of the WP/ facility, including the area 4 NM beyond the outer boundary. When the distance from the facility to the airport exceeds 25 NM, the radius shall be expanded to include the airport landing surfaces up to a maximum distance of 30 NM (see Figure 2-2-1). When the procedure does not use an omnidirectional facility, e.g. LOC [BC] with a fix for the FAF, use the primary omnidirectional facility in the area. If necessary to offer relief from obstacles, establish sector divisions, or a common safe altitude (no sectors) for the entire area around the facility. Sectors shall not be less than 90° in spread. Sector altitudes should be raised and combined with adjacent higher sectors when a height difference does not exceed 300 feet. A sector altitude shall also provide 1,000 feet of obstacle clearance in the adjacent sector or periphery area within 4 NM of the sector boundary line. For area navigation (RNAV) procedures, establish a common altitude within the specified radius of the runway waypoint (RWY WP), (normally the MAWP), for straight-in approaches; the airport waypoint (APT WP) for circling procedures; or for GPS approaches, from the WP used for the MSA centre (see Figure 2-2-2). APT WP is the same as the geographic centre of aerodrome.

b. Safe Altitude 100 NM. A safe altitude shall be established within a 100-NM radius of the geographic centre of the aerodrome. Where a requirement exists for these altitudes, these shall be established with a common altitude for the entire area. Where these altitudes are established in designated mountainous regions, they shall provide the appropriate obstacle clearance, either 1,500 or 2,000 feet. These altitudes shall be identified in published procedures as "Safe Altitude 100 NM".

Supplementary Notes:

1) With respect to the 100 NM safe altitudes, only the obstacles located within the designated mountainous regions receive the mountainous ROC, other obstacles receive the normal 1000 ft ROC

2) Use 2000 ft of ROC over eastern U.S. designated mountainous terrain areas.

222—229. reserved
Figure 2-2-1: Non-RNAV MSA. Para 221.

Figure 2-2-2: RNAV MSA. Para 221.
SECTION 3. INITIAL APPROACH

230. Initial Approach Segment
The instrument approach commences at the IAF. In the initial approach the aircraft has departed the en route phase of flight, and is maneuvering to enter the intermediate segment. When the IF is part of the en route structure, it may not be necessary to designate an initial approach segment. In this case the approach commences at the IF and intermediate segment criteria apply. An initial approach may be made along an arc, radial, course, heading, or radar vector, or a combination thereof. Procedure turns, holding pattern descents, and high altitude penetrations are initial segments. Positive course (track) guidance is required except when dead reckoning courses can be established over limited distances. Although more than one initial approach may be established for a procedure, the number should be limited to that which is justified by traffic flow or other operational requirements. Where holding is required prior to entering the initial approach segment, the holding fix and IAF should coincide. When this is not possible the IAF shall be located within the holding pattern on the inbound holding course.

231. Altitude Selection
Minimum altitudes in the initial approach segment shall be established in 100-foot increments; i.e., 1,549 feet may be shown as 1,500 feet as long as the ROC is not violated and 1,550 shall be shown as 1,600 feet. The altitude selected shall not be below the PT altitude where a PT is required. In addition, altitudes specified in the initial approach segment must not be lower than any altitude specified for any portion of the intermediate or final approach segments.

232. Initial Approach Segments Based On Straight Courses And Arcs With Positive Course Guidance (PCG)
a. Alignment.
   (1) Courses. The angle of intersection between the initial approach course and the intermediate course shall not exceed 120°. When the angle is 90° or greater, a lead radial/bearing, which provides 2 NM of lead, shall be identified to assist in leading the turn onto the intermediate course (see Figure 2-3).
   (2) Arcs. An arc may provide course guidance for all or a portion of an initial approach. The minimum arc radius shall be 7 NM, except for high altitude procedures, in which the minimum radius shall be at least 15 NM. When an arc of less than 15 NM radius is used in high altitude procedures, the descent gradient along the arc shall not exceed the criteria in Para 232.d and Table 2-1. An arc may join a course at or before the IF. When joining a course on or before the IF, the angle of intersection of the arc and the fix course shall not exceed 120°. When the angle is 90° or greater, a fix, lead radial or lead bearing which provides at least 2 NM of lead shall be identified to assist in leading the turn onto the intermediate course. DME arc courses should be predicated on collocated VOR/DME, NDB/DME or TACAN facilities. Where an operational advantage can be achieved non-collocated facilities may be used providing the two facilities are within 4 NM of each other and the angle subtended by the line joining the aircraft to the DME source and the bearing to the track guidance facility does not exceed 8°.
### Formula 2-1. Distance Flown Along Arc, Distance to Lead Radial/Bearing. Para 232.a.

<table>
<thead>
<tr>
<th>Math Notation</th>
<th>Standard Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_{ARC} = \frac{Radius \times Angle}{57.3}$</td>
<td>$D_{ARC} = \frac{(Radius \times Angle)}{57.3}$</td>
</tr>
<tr>
<td>$LR or LB = \frac{(2 \times 57.3)}{Radius}$</td>
<td>$LR or LB = \frac{(2 \times 57.3)}{Radius}$</td>
</tr>
</tbody>
</table>

#### Given Values
- **Radius** = Radius of arc flown (NM)
- **$D_{ARC}$** = Distance flown along arc (NM)
- **LR or LB** = Lead Radial (LR) or Lead Bearing (LB)
- **Angle** = number of degrees of arc flown

---

**b. Area.** The initial approach segment has no standard length. The length shall be sufficient to permit the altitude change required by the procedure and shall not exceed 50 NM unless an operational requirement exists. The total width of the initial approach segment shall be 6 NM on each side of the initial approach course. This width is divided into a primary area, which extends laterally 4 NM on each side of the course, and a secondary area, which extends laterally 2 NM on each side of the primary area (see Figure 2-10). When any portion of the initial approach is more than 50 NM from the navigation facility, the criteria for en route airways shall apply to that portion.

**c. Obstacle Clearance.** The obstacle clearance in the initial approach primary area shall be a minimum of 1,000 feet. In the secondary area 500 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge (see Figure 2-6a). Allowance for precipitous terrain should be made, as specified in Para 323.b. The altitudes selected by application of the obstacle clearance specified in this paragraph shall be rounded to the next higher 100-foot increment (see Para 231).

**d. Descent Gradient.** The OPTIMUM descent gradient in the initial approach is 250 feet per nautical mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per nautical mile. The OPTIMUM descent gradient for high altitude penetrations is 800 feet per nautical mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 1,000 feet per nautical mile. The maximum descent gradient for a high altitude arc of less than 15-mile radius is found in Table 2-1.
Figure 2-3: Initial approach interception angle greater than 90 degrees 232.a.(1)

<table>
<thead>
<tr>
<th>MILES (NM)</th>
<th>Max Ft. Per NM</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1,000</td>
</tr>
<tr>
<td>14</td>
<td>720</td>
</tr>
<tr>
<td>13</td>
<td>640</td>
</tr>
<tr>
<td>12</td>
<td>560</td>
</tr>
<tr>
<td>11</td>
<td>480</td>
</tr>
<tr>
<td>10</td>
<td>400</td>
</tr>
<tr>
<td>9</td>
<td>320</td>
</tr>
<tr>
<td>8</td>
<td>240</td>
</tr>
<tr>
<td>7</td>
<td>160</td>
</tr>
</tbody>
</table>

Table 2-1: Descent Gradient On High Altitude Arc Of Less Than 15 NM. Para 232a(2).
233. Initial Approach Segment Based On Dead Reckoning (DR)

a. **Alignment.** Each DR course shall intercept the extended intermediate course. For LOW altitude procedures the intercept point shall be at least 1 mile from the IF for each 2 NM of DR flown. For HIGH altitude procedures the intercept point shall be 1 mile prior to the IF for each 3 NM of DR flown. The intercept angle shall:

   (1) not exceed 90°; and
   (2) not be less than 45° except when DME is used or the DR distance is 3 NM or less.

b. **Area.** The MAXIMUM length of the DR portion of the initial segment is 10 NM (except Para 232.b applies for HIGH altitude procedures where DME is available throughout the DR segment). Where the DR course begins, the width is 6 NM on each side of the course, expanding outward by 15° until joining the points as depicted in Figures 2-4-1, 2-4-2, 2-4-3, 2-4-4, and 2-4-5.

c. **Obstacle Clearance.** The obstacle clearance in the DR initial approach segment shall be a minimum 1,000 feet. There is no secondary area. Allowance for precipitous terrain shall be considered as specified in Para 323.b. The altitudes selected by application of the obstacle clearance specified in this paragraph shall be rounded in accordance with Para 231.

d. **Descent Gradient.** The OPTIMUM descent gradient in the initial approach is 250 feet per mile. Where a higher descent gradient is necessary, the maximum permissible gradient is 500 feet per nautical mile. The OPTIMUM descent gradient for high altitude penetrations is 800 feet per nautical mile. Where a higher descent gradient is necessary, the maximum permissible gradient is 1,000 feet per nautical mile.
Outside and Inside Turns: Truncate segment at intersection of 15° expansion line and initial width centered on reciprocal of intermediate.

Figure 2-4-1: Example DR Segment. Para 233.b.
**Inside Turn:** Do not truncate when 15° expansion line does not intersect initial width centered on reciprocal of intermediate. When this part of the initial does not overlap the intermediate, DME is required.

*Figure 2-4-2: Example DR Segment. Para 233.b.*
Outside and Inside Turns: Truncate segment at intersection of 15° expansion line and initial width centered on reciprocal of intermediate.

Figure 2-4-3: Example DR Segment. Para 233.
**Outside / Inside Turn:** Extend segment to intersection of 15° expansion line and initial width centered on reciprocal of intermediate.

**Inside Turn:** Do not truncate when 15° expansion line does not intersect initial width centered on reciprocal of intermediate. Continue to expand until reaching line perpendicular to DR course abeam IF.

*Figure 2-4-4: Example DR Initial Segment. Para 233.b.*
Outside Turn: Truncate segment at intersection of 15° expansion line and initial width centered on reciprocal of intermediate.

Inside Turn: Do not truncate when 15° expansion line does not intersect initial width centered on reciprocal of intermediate. Continue to expand until reaching line perpendicular to DR course abeam IF.

Figure 2-4-5: DR Initial Segment With Boundary Outside The Intermediate Segment. Para 233.b.
234. Initial Approach Segment Based On A Procedure Turn (PT)

A PT shall be specified when it is necessary to reverse direction to establish the aircraft on an intermediate or final approach course (FAC) except as specified in Para 234.e. A PT begins by overheading a facility or fix which meets the criteria for a holding fix (see Para 287.b) or for a FAF (see Para 287.c). The procedure shall specify the PT fix, the outbound and inbound course, the distance within which the PT shall be completed, and the direction of the PT. When a teardrop turn is used, the angle of divergence between the outbound course and the reciprocal of the inbound course shall be a MINIMUM of 15° or a MAXIMUM of 30° (see Para 235.a for high altitude teardrop penetrations). When the beginning of the intermediate or final approach segment associated with the PT is marked by no fix, the segment is deemed to begin on the inbound PT course at the maximum distance specified in the procedure. Where neither segment is marked by a fix, the final segment begins at the maximum distance specified in the procedure.

a. Alignment. When the inbound course of the procedure turn becomes the intermediate course it must meet the intermediate course alignment criteria. (See Para 242.a.) When the inbound course becomes the final approach course it must meet the final approach course alignment criteria. (See Para 250.) The wider side of the procedure turn area shall be oriented in the same direction as that prescribed for the procedure turn.

b. Area. The procedure turn areas are depicted in Figure 2-5. The normal procedure turn distance is 10 NM, (see Table 2-1A). Decrease this distance to 5 NM where only CAT "A" aircraft or helicopters are to be operating, and increase to 15 NM to accommodate operational requirements, or as specified in Para 234d. No extension of the PT is permitted without a FAF. When a procedure turn is authorized for use by Category "E" aircraft, a 15-mile PT distance shall be used. The PT segment is made up of the entry and maneuvering zones. The entry zone terminates at the inner boundary which extends perpendicular to the PT inbound course at the PT fix. The remainder of the procedure turn segment is the maneuvering zone. The entry and maneuvering zones are made up of primary and secondary areas. The PT primary area dimensions are based on the PT completion altitude, or the highest feeder route altitude, whichever is greater. To allow additional maneuvering area as the true airspeed increases at higher altitudes, the dimension of the PT primary area increases (see Table 2-1A). The PT secondary area is 2 NM on the outside of the primary area.

c. Obstacle Clearance. A minimum of 1,000 feet of clearance shall be provided in the primary area. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge (see Figure 2-6 and 2-6a). Allowance for precipitous terrain shall be considered as specified in Para 323.b. The primary and secondary areas determine obstacle clearance in both the entry and maneuvering zones. The use of entry and maneuvering zones provides further relief from obstacles. The entry zone is established to control the obstacle clearance until proceeding outbound from the procedure turn fix. The maneuvering zone is established to control obstacle clearance AFTER proceeding outbound from the procedure turn fix. (see Figure 2-5). The altitudes selected by application of the obstacle clearance specified in this paragraph shall be rounded to the next higher 100 feet increment (see Para 231).
d. **Descent Gradient.** The OPTIMUM descent gradient in the initial approach is 250 feet per nautical mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per nautical mile. Where a PT is established over a FAF, the PT completion altitude should be as close as possible to the FAF altitude. The difference between the PT completion altitude and the altitude over the FAF shall not be greater than those shown in Table 2-1B. If greater differences are required for a 5 or 10 nautical mile PT, the PT distance limits and maneuvering zone shall be increased at the rate of 1 nautical mile for each 200 feet of required altitude.

e. **Elimination of PT.** A PT is NOT required when an approach can be made direct from a specified IF to the FAF. The abbreviation "No PT" is used to denote that no procedure is necessary and will normally be shown adjacent to the IF. However, if the minimum altitude IF to FAF is not readily apparent, the No PT abbreviation will be shown at some point between the fix and the FAF. Design criteria outlined in Para 240-244 applies. Publishing an IF to permit a No PT approach does not preclude the publishing of a procedure turn as well, where operationally appropriate. A PT NEED NOT be established when an approach can be made from a properly aligned holding pattern. See Para 1820.a. In this case, the holding pattern in lieu of a PT, shall be established over a final or intermediate approach fix and the following conditions apply:

(1) If the holding pattern is established over the FAF (not applicable to RNAV procedures), an intermediate segment is not constructed. Ideally, establish the minimum holding altitude at the FAF altitude. In any case, the published holding altitude shall not be more than 300 feet above the FAF altitude.

(2) If the holding pattern is established over the IF, the minimum holding altitude (MHA) shall permit descent to the FAF altitude within the descent gradient tolerances prescribed for the intermediate segment (see Para 242d).
\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|}
\hline
\textbf{PT Length} & \textbf{Offset} & \textbf{R}_1 & \textbf{R}_2 & \textbf{R}_3 & \textbf{R}_4 \\
\hline
\leq 6,000 & & & & & \\
\hline
5 & 2 & 4 & 6 & 5 & 7 \\
\hline
>5-10 & 2 & 5 & 7 & 6 & 8 \\
\hline
>10-15 & \beta-4 & 5 & 7 & \beta & \beta+2 \\
\hline
\text{Where } \beta = 0.1 \times (d - 10) + 6 \\
\text{Where } d = PT Length \text{ (NM)} \\
\hline
\end{tabular}
\end{table}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|}
\hline
\textbf{PT Length} & \textbf{Offset} & \textbf{R}_1 & \textbf{R}_2 & \textbf{R}_3 & \textbf{R}_4 \\
\hline
\leq 6,000 & & & & & \\
\hline
5 & 2 & 4 & 6 & 5 & 7 \\
\hline
\begin{tabular}{c}
>5-10 \\
>10-15
\end{tabular} & \beta-5 & 6 & 8 & \beta & \beta+2 \\
\hline
\text{Where } \beta = 0.1 \times (d - 10) + 7 \\
\text{Where } d = PT Length \text{ (NM)} \\
\hline
\end{tabular}
\end{table}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|}
\hline
\textbf{PT Length} & \textbf{Offset} & \textbf{R}_1 & \textbf{R}_2 & \textbf{R}_3 & \textbf{R}_4 \\
\hline
\leq 6,000 & & & & & \\
\hline
5 & 2 & 4 & 6 & 5 & 7 \\
\hline
\begin{tabular}{c}
>5-10 \\
>10-15
\end{tabular} & \beta-6 & 7 & 9 & \beta & \beta+2 \\
\hline
\text{Where } \beta = 0.1 \times (d - 10) + 8 \\
\text{Where } d = PT Length \text{ (NM)} \\
\hline
\end{tabular}
\end{table}

\begin{table}[h]
\centering
\begin{tabular}{|l|l|}
\hline
\textbf{Type of PT} & \textbf{Altitude Difference} \\
\hline
15 NM PT from FAF & Within 3,000 ft of ALT over FAF \\
\hline
10 NM PT from FAF & Within 2,000 ft of ALT over FAF \\
\hline
5 NM PT from FAF & Within 1,000 ft of ALT over FAF \\
\hline
15 NM PT, no FAF & Not Authorized \\
\hline
10 NM PT, no FAF & With 1,500 ft of MDA on Final \\
\hline
5 NM PT, no FAF & With 1,000 ft of MDA on Final \\
\hline
\end{tabular}
\caption{Table 2-1A: Procedure Turn Variables According To ASL Altitude, Para 234b.}
\end{table}

\begin{table}[h]
\centering
\begin{tabular}{|l|l|}
\hline
\textbf{Type of PT} & \textbf{Altitude Difference} \\
\hline
15 NM PT from FAF & Within 3,000 ft of ALT over FAF \\
\hline
10 NM PT from FAF & Within 2,000 ft of ALT over FAF \\
\hline
5 NM PT from FAF & Within 1,000 ft of ALT over FAF \\
\hline
15 NM PT, no FAF & Not Authorized \\
\hline
10 NM PT, no FAF & With 1,500 ft of MDA on Final \\
\hline
5 NM PT, no FAF & With 1,000 ft of MDA on Final \\
\hline
\end{tabular}
\caption{Table 2-1B: PT Completion Altitude Difference. Para 234d.}
**Note:** In the **normal** PT area example above:
R1 = 5 NM, R2 = 7 NM, R3 = 6 NM, and R4 = 8 NM.
In the **optional** PT area example above:
R1 = 4 NM, R2 = 6 NM, R3 = 5 NM, and R4 = 7 NM.

**Figure 2-5: Procedure Turn Areas. Para 234.b.**
Figure 2-6: Procedure Turn Initial Approach Area. Para 234.c.
235. Initial Approach Based On High Altitude Teardrop Penetration

A teardrop penetration consists of departure from an IAF on an outbound course, followed by a turn toward and intercepting the inbound course at or prior to the IF or point. Its purpose is to permit an aircraft to reverse direction and lose considerable altitude within reasonably limited airspace. Where no IF is available to mark the beginning of the intermediate segment, it shall be assumed to commence at a point 10 NM prior to the FAF. When the facility is located on the airport, and no fix is available to mark the beginning of the final approach segment the criteria in Para 423 applies.

a. Alignment. The outbound penetration course shall be between 18 and 26° to the left or right of the reciprocal of the inbound course. The actual angular divergence between the courses will vary inversely with the distance from the facility at which the turn is made (see Table 2-2).

b. Area.

(1) Size. The size of the penetration turn area must be sufficient to accommodate both the turn and the altitude loss required by the procedure. The penetration turn distance shall not be less than 20 NM from the facility. The penetration turn distance depends on the altitude to be lost in the procedure and the point at which the descent is started (see Table 2-2). The aircraft should lose half the altitude or 5,000 ft., whichever is greater, outbound prior to starting the turn. The penetration turn area has a width of 6 NM on both sides of the flight track up to the IF or point, and shall encompass all the areas within the turn (see Figure 2-7).

(2) Penetration Turn Table. Table 2-2 should be used to compute the desired course divergence and penetration turn distances, which apply when a specific altitude loss outbound is required. It is assumed that the descent begins at the plotted position of the fix. When the procedure requires a delay before descent of more than 5 NM, the distance in excess of 5 NM should be added to the distance the turn commences. The course divergence and penetration turn distance should then be adjusted to correspond to the adjusted turn distance. Extrapolations may be made from the table.

(3) Primary and Secondary Areas. All of the penetration turn area, except the outer 2 NM of the 6 NM obstacle clearance area on the outer side of the penetration track, is primary area (see Figure 2-7). The outer 2 NM is secondary area. The outer 2 NM on both sides of the inbound penetration course should be treated as secondary area.

c. Obstacle Clearance. Obstacle clearance in the initial approach primary area shall be a MINIMUM of 1,000 feet. Obstacle clearance at the inner edge of the secondary area shall be 500 feet, tapering to zero feet at the outer edge (see Figure 2-6a). Where no IF is available, a 10 NM intermediate segment is assumed and normal obstacle clearance is applied to the controlling obstacle. The controlling obstacle, as well as the minimum altitude selected for the intermediate segment, may depend on the availability of an IF (see Figure 2-8). Allowance for precipitous terrain should be considered in the penetration turn area as specified in Para 323.b. The altitudes selected by application of the obstacle clearance specified in this paragraph shall be rounded to the next higher 100 feet increment. (See Para 231.)

d. Descent Gradient. The OPTIMUM descent gradient is 800 feet per nautical mile. The MAXIMUM gradient is 1,000 feet per nautical mile.

e. Penetration Turn Altitude. When an IF is NOT provided, the penetration turn completion altitude shall not be more than 4,000 feet above the FAF altitude.
<table>
<thead>
<tr>
<th>ALT to be Lost Prior to Commencing Turn (ft)</th>
<th>Distance Turn Commences (NM)</th>
<th>Course Divergence (Degrees)</th>
<th>Specified Penetration Turn Distance (NM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12,000</td>
<td>24</td>
<td>18</td>
<td>28</td>
</tr>
<tr>
<td>11,000</td>
<td>23</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td>10,000</td>
<td>22</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>9,000</td>
<td>21</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>8,000</td>
<td>20</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>7,000</td>
<td>19</td>
<td>23</td>
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</tr>
<tr>
<td>6,000</td>
<td>18</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>5,000</td>
<td>17</td>
<td>25</td>
<td>21</td>
</tr>
<tr>
<td>4,000</td>
<td>16</td>
<td>26</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 2-2: Penetration Turn Distance/Divergence. Para 235a.
Primary ROC = 1000' + adjustments (adj)

Secondary ROC = \((500' + adj) \times \frac{(W_S - d)}{W_S}\)

Where:
- \(d\) = distance from inner edge to obstacle (ft)
- \(W_S\) = Width of secondary area (ft)
- \(adj\) = adjustments (ft) as per para 323.

Figure 2-6a: Obstacle Clearance Areas. Paras 234.c and 235.c.

Figure 2-7: Typical Penetration Turn Initial Approach Area. Para 235.
Figure 2-8: Penetration Turn Initial Approach Obstacle Clearance. Para 235.c.
236. Initial Approach Course Reversal Using Non-Collocated Facilities And A Turn Of 120° Or Greater To Intercept The Inbound Course (see Figures 2-9-1, 2-9-2, and 2-9-3)

   (1) A turn point (TP) fix shall be established as shown in the figures. The fix error shall meet section 8 criteria, and shall not exceed plus-or-minus 2 NM.
   (2) A flight path radius of 2.8 NM shall be used for procedures where the altitude at the TP fix is at or below 10,000 feet MSL, or 4 NM for procedures where the altitude at the TP fix is above 10,000 feet MSL.
   (3) **Descent Gradient.** Para 232.d applies.
   (4) **Obstacle Clearance.** Para 235.c applies.
   (5) **Initial Distance.** When the course reversal turn intercepts the extended intermediate course, and when the course reversal turn intercepts a straight segment prior to intercepting the extended intermediate course, the minimum distance between the rollout point and the FAF is 10 NM.
   (6) **ROC Reduction.** No reduction of secondary ROC is authorized in the course reversal area unless the TP fix is DME.

b. Figures 2-9-1 and 2-9-2. The rollout point shall be at or prior to the intermediate fix/point.
   (1) Select the desired rollout point on the inbound course.
   (2) Place the appropriate flight path arc tangent to the rollout point.
   (3) From the outbound facility, place the outbound course tangent to the flight path arc. The point of tangency shall be the TP fix.

c. Figure 2-9-3.
   (1) The point of intersection shall be at or prior to the IF/point (Para 242 applies). The angle shall be 90° or less.
   (2) The distance between the rollout point and the point of intersection shall be no less than the distance shown in Table 2-2A.
   (3) Para 235 and Table 2-2 should be used for high altitude procedures up to the point of intersection of the two inbound courses.
   (4) Select the desired point of intersection. From the outbound facility draw a line through the point of intersection.
   (5) At the outbound facility, measure the required number of degrees course divergence (may be either side of the line through the point of intersection) and draw the outbound course out the required distance. Connect the outbound course and the line through the point of intersection with the appropriate arc.
   (6) Determine the desired rollout point on the line through the point of intersection.
      (a) Place the appropriate flight path arc tangent to the rollout point.
      (b) From the outbound facility draw the outbound course tangent to the flight path arc. The point of tangency is the TP fix.
### Table 2-2A: Minimum Distance From Roll Out Point To Point Of Intersection. Para 236c(2).

<table>
<thead>
<tr>
<th>Angle “e” (Degrees)</th>
<th>NM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 15</td>
<td>1</td>
</tr>
<tr>
<td>&gt; 15 – 30</td>
<td>2</td>
</tr>
<tr>
<td>&gt; 30 – 45</td>
<td>3</td>
</tr>
<tr>
<td>&gt; 45 – 60</td>
<td>4</td>
</tr>
<tr>
<td>&gt; 60 – 75</td>
<td>5</td>
</tr>
<tr>
<td>&gt; 75 – 90</td>
<td>6</td>
</tr>
</tbody>
</table>
Figure 2-9-1: Example Of Initial Course Reversal. Para 236.
Figure 2-9-2 – Examples Of Initial Course Reversal. Para 236.
Figures 2-9-3 – Examples Of Initial Course Reversal. Para 236.

Note: When $R = 2.8$, $R_1 = 8.8$
When $R = 4$, $R_1 = 10$
SECTION 4. INTERMEDIATE APPROACHES

240. Intermediate Approach Segment

This is the segment which blends the initial approach segment into the final approach segment. It is the segment in which aircraft configuration, speed, and positioning adjustments are made for entry into the final approach segment. The intermediate segment begins at the IF point, and ends at the FAF. There are two types of intermediate segments: the "radial" or "course" intermediate segment and the "arc" intermediate segment. In either case, positive course guidance (PCG) shall be provided. See Figure 2-10 for typical approach segments.

![Figure 2-10: Typical Approach Segments. Paras 232.b and 240.](image-url)
241. Altitude Selection

The MINIMUM altitude in the intermediate segment shall be established in 100-foot increments, without violating the ROC; i.e., 749 feet may be shown as 700 feet and 750 feet shall be shown as 800. In addition, the altitude selected for arrival over the FAF should be low enough to permit descent from the FAF to the airport for a straight-in landing whenever possible.

242. Intermediate Approach Segment Based On Straight Courses

a. **Alignment.** The course to be flown in the intermediate segment shall be the same as the final approach course, except when the final approach fix is the navigation facility and it is not practical for the course to be identical. In such cases, the intermediate course shall not differ from the final approach course by more than 30° (see Figure 2-10).

b. **Area.**

   (1) **Length.** The length of the intermediate segment is measured along the course to be flown. Where the initial segment joins the intermediate segment at angles up to 90°, the MINIMUM length is 5 NM for CAT A/B, and 6 NM for CAT C/D/E (except as specified in Volume 1, chapter 10 and 16, and Volume 3, chapter 2). Table 2-3 lists the minimum segment length where the initial approach course joins the intermediate course at an angle greater than 90° (see Figure 2-3). The MAXIMUM segment length is 15 NM. The OPTIMUM length is 10 NM. A distance greater than 10 NM should not be used unless an operational requirement justifies a greater distance.

   (2) **Width.** The width of the intermediate segment is the same as the width of the segment it joins. When the intermediate segment is aligned with the initial or final approach segments, the width of the intermediate segment is determined by joining the outer edges of the initial segment with the outer edges of the final segment. When the intermediate segment is not aligned with the initial or final approach segments, the resulting gap on the outside of the turn is part of the preceding segment is closed by the appropriate arc (see Figure 2-10). For obstacle clearance purposes the intermediate segment is divided into a primary and a secondary area.

c. **Obstacle Clearance.** A minimum of 500 feet of obstacle clearance shall be provided in the primary area of the intermediate approach segment. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge (see Figure 2-10a). Allowance for precipitous terrain and RASS shall be considered as specified in Para 323.b. & c. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet, provided the ROC is not violated (see Para 241).

d. **Descent Gradients.** Because the intermediate segment is used to prepare the aircraft speed and configuration for entry into the final approach segment, the gradient should be as flat as possible. The OPTIMUM descent gradient is 150 feet per nautical mile. The MAXIMUM gradient is 318 feet per nautical mile, except for a localizer approach published in conjunction with an ILS procedure. In this case, a higher descent gradient equal to the commissioned GS angle (provided it does not exceed 3°) is permissible. Higher gradients resulting from arithmetic rounding are also permissible.

**Supplementary Notes:**

1) The intent of paragraph 242 d) is that the localizer descent gradient must not be higher than the published glideslope angle. For example, a localizer published in conjunction with an ILS that has a 2.75° glide slope, must not have an
intermediate segment descent gradient greater than 291 ft/nm. In this case, the maximum gradient of 318ft/nm specified in para 242d would not be applicable.

2) When the descent gradient exceeds 318 feet per nautical mile, the procedure specialist should assure an initial segment is provided prior to the intermediate segment to prepare the aircraft speed and configuration for entry into the final segment. The initial segment should be a minimum length of 5 NM and its descent gradient should not exceed 318 feet per nautical mile.

<table>
<thead>
<tr>
<th>Angle (Degrees)</th>
<th>Minimum Length (NM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>91 – 96</td>
<td>6</td>
</tr>
<tr>
<td>&gt; 96 – 102</td>
<td>7</td>
</tr>
<tr>
<td>&gt; 102 – 108</td>
<td>8</td>
</tr>
<tr>
<td>&gt; 108 – 114</td>
<td>9</td>
</tr>
<tr>
<td>&gt; 114 – 120</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2-3: Minimum Intermediate Course Length (NM). Para 242.b(1).

\[
\text{Secondary ROC} = \left(500 + \text{adj}\right) \times \frac{(W_S - d)}{W_S}
\]

Where: 
- \(d\) = distance from inner edge to obstacle (ft)
- \(W_S\) = Width of secondary area (ft)
- Adjustments = adjustments (ft) as per para 323.

Figure 2-10a: Obstacle Clearance Area. Paras 242.c and 243.c.
243. Intermediate Approach Segment Based On An Arc

Arcs with a radius of less than 7 NM or more than 30 NM from the navigation facility shall NOT be used. DME arc courses shall be predicated only on a DME collocated with a facility providing omnidirectional course information.

a. Alignment. The same arc shall be used for the intermediate and the final approach segments. No turns shall be required over the FAF.

b. Area.

(1) Length. The intermediate segment shall NOT be less than 5 NM or more than 15 NM in length, measured along the arc. The OPTIMUM length is 10 NM. A distance greater than 10 NM should not be used unless an operational requirement justifies the greater distance.

(2) Width. The total width of an arc intermediate segment is 6 NM on each side of the arc. For obstacle clearance purposes, this width is divided into a primary and a secondary area. The primary area extends 4 NM laterally on each side of the arc segment. The secondary areas extend 2 NM laterally on each side of the primary area (see Figure 2-10).

c. Obstacle Clearance. A minimum of 500 feet of obstacle clearance shall be provided in the primary area. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge (see Figure 2-10a). Allowance for precipitous terrain should be considered as specified in Para 323.b. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet, provided the ROC is not violated. (See Para 241.)


244. Intermediate Approach Segment Within A PT Segment

a. PT Over a FAF. When the FAF is a Facility (see Figure 2-11).

(1) The MAXIMUM intermediate length is 15 NM, the OPTIMUM is 10 NM, and the MINIMUM is 5 NM. Its width is the same as the final segment at the facility and expanding uniformly to 6 NM on each side of the course at 15 NM from the facility.

(2) The intermediate segment considered for obstacle clearance shall be the same length as the PT distance; e.g., if the procedure requires a PT to be completed within 5 NM, the intermediate segment shall be only 5 NM long, and the intermediate approach shall begin on the intermediate course 5 NM from the FAF.

(3) When establishing a step down fix within intermediate segment underlying a PT area:

(a) Table 2-1A shall be applied.

(b) Only one step down fix is authorized within the intermediate segment that underlies the PT maneuvering area.

(c) The distance between the PT fix/facility and a SDF underlying the PT area shall not exceed 4 NM.

(d) The MAXIMUM descent gradient from the IF point to the SDF is 200 feet/NM. The MAXIMUM descent gradient from the SDF to the FAF is 318 feet/NM.
b. **PT Over a FAF When the FAF is Not a Facility** (see Figure 2-12).

1. The intermediate segment shall be 6 NM wide each side of the intermediate course at the PT distance.

2. When establishing a step down fix within intermediate/initial segment underlying a PT area:
   
   a. Table 2-1A shall be applied.
   
   b. Only one step down fix is authorized within the intermediate segment that underlies the PT maneuvering area.
   
   c. The distance between the PT fix/facility and a SDF underlying the PT area shall not exceed 4 NM.
   
   d. The MAXIMUM descent gradient from the IF point to the SDF is 200 feet/NM. The MAXIMUM descent gradient from the SDF to the FAF is 318 feet/NM.

c. **PT Over a Facility/Fix After the FAF** (see Figure 2-13).

1. The PT facility/fix to FAF distance shall not exceed 4 NM.

2. The MAXIMUM PT distance is 15 NM.

3. The length of the intermediate segment is from the start of the PT distance to the FAF and the MINIMUM length shall be 5 NM.

4. **Intermediate Segment Area.**

   a. PT Over a Facility. The intermediate segment starts 15 NM from the facility at a width of 6 NM each side of the inbound course and connects to the width of the final segment at the FAF. The area considered for obstacle clearance is from the start of the PT distance to the FAF.

   b. PT Over a Fix (NOT a Facility). The intermediate segment starts at the PT distance at a width of 6 NM each side of the inbound course and connects to the width of the final segment at the FAF. The area considered for obstacle clearance is from the start of the PT distance to the FAF.

5. The MAXIMUM descent gradient in the intermediate segment is 200 feet/NM. The PT distance may be increased in 1 NM increments up to 15 NM to meet descent limitations.

6. When establishing a step down fix within intermediate/initial segment underlying a PT area:

   a. Only one step down fix is authorized within the intermediate segment that underlies the PT maneuvering area.

   b. The distance between the PT fix/facility and a stepdown fix (SDF) underlying the PT area shall not exceed 4 NM.

   c. The MAXIMUM descent gradient from the IF point to the SDF is 200 feet/NM. The MAXIMUM descent gradient from the SDF to the FAF is 318 feet/NM.

d. **PT Over a Facility/Fix PRIOR to the FAF** (see Figures 2-14-1 and 2-14-2).

1. The MINIMUM PT distance is 5 NM.

2. The length of the intermediate segment is from the start of the PT distance to the FAF and the MAXIMUM length is 15 NM.
(3) Intermediate Segment Area.
   (a) PT Over a Facility. The intermediate segment starts 15 NM from the facility at a
       width of 6 NM each side of the inbound course and connects to the width of the
       final segment at the FAF. The area considered for obstacle clearance is from the
       start of the PT distance to the FAF.
   (b) PT Over a Fix (NOT a Facility). The intermediate segment starts at the PT distance
       at a width of 6 NM each side of the inbound course and connects to the width of
       the final segment at the FAF. The area considered for obstacle clearance is from
       the start of the PT distance to the FAF.

(4) The MAXIMUM descent gradient is 200 feet/NM. If the PT facility/fix is a step-down
    fix, the descent gradient from the step-down fix to the FAF may be increased to a
    maximum of 318 feet/NM (see Figure 2-14-2). The PT distance may be increased in
    1 NM increments up to 15 NM to meet descent limitations.

(5) When establishing a step down fix within an intermediate/initial segment underlying a
    PT area:
       (a) When the PT fix is over a facility/fix prior to the FAF, the facility/fix is the SDF in
           the intermediate/initial area, and another SDF within this segment is not
           authorized.
       (b) The MAXIMUM descent gradient from the IF point to the SDF is 200 feet/NM. The
           MAXIMUM descent gradient from the SDF to the FAF is 318 feet/NM.

e. PT Facility/Fix Used as an Intermediate Fix (see Figure 2-14-3).
   (1) When the PT inbound course is the same as the intermediate course, either
       Para 244.d may be used, or a straight initial segment may be used from the start of
       the PT distance to the PT fix.
   (2) When the PT inbound course is NOT the same as the intermediate course, an
       intermediate segment within the PT area is NOT authorized; ONLY a straight initial
       segment shall be used from the start of the PT distance to the PT fix.
   (3) When a straight initial segment is used, the MAXIMUM descent gradient within the PT
       distance is 318 feet/NM, the PT distance may be increased in 1 NM increments up to
       15 NM to meet descent limitations.
   (4) When establishing a step down fix within an intermediate/initial segment underlying a
       PT area:
       (a) Only one step down fix is authorized within the initial segment that underlies the
           PT maneuvering area.
       (b) The distance from the PT fix/facility and a SDF underlying the PT area shall not
           exceed 4 NM.
       (c) The MAXIMUM descent gradient from the PT completion point (turn distance) to
           the SDF, and from the SDF to the IAF is 318 feet/NM.

f. When a PT from a facility is required to intercept a localizer course, the PT facility is
   considered on the localizer course when it is located within the commissioned localizer
   course width.

245—249. Reserved
Figure 2-11: Intermediate Area Within A Procedure Turn Area. FAF Is The Facility. Para 244.a.
Figure 2-12: Intermediate Area Within The Procedure Turn Area. FAF Is Not The Facility. Para 244.b.
Figure 2-13: Intermediate Area Within The Procedure Turn. PT Over The Facility/Fix After The FAF. Para 244.c.
Figure 2-14-1: Intermediate Area Within The Procedure Turn Area. PT Over The Facility/Fix Prior To The FAF. Para 244.d.
Figure 2-14-2: Intermediate Area Within The Procedure Turn Area. PT Facility/Fix Used As A Stepdown Fix. Para 244.d.(4).
Figure 2-14-3: Use Of PT Fix For IF. Para 244.e.

Figure 2-14-4 to 2-14-6: Reserved
SECTION 5. FINAL APPROACH

250. Final Approach Segment
This is the segment in which alignment and descent for landing are accomplished. The final approach segment considered for obstacle clearance begins at the FAF or points and ends at the runway or missed approach point (MAP), whichever is encountered last. Final approach may be made to a runway for straight-in landing, or to an airport for a circling approach. Since the alignment and dimensions of the non-visual portions of the final approach segment vary with the location and type of navigation facility, applicable criteria are contained in chapters designated for specific navigation facilities.

251. Reserved

252. Descent Angle/Gradient.
The OPTIMUM non precision final segment descent gradient is 318 FT/NM, which approximates a 3.00° angle. The MAXIMUM descent gradient is 400 ft/NM, which approximates a descent angle of 3.77°. Calculate descent gradient from the plotted position of the FAF or SDF to the plotted position of the SDF or final endpoint (FEP) as appropriate (see Figure 2-14-7). The FEP is formed by the intersection of the FAC and a line perpendicular to the FAC that extends to the runway threshold (first useable landing surface for circling only procedures). When the maximum descent gradient is exceeded, straight-in minimums are NOT authorized; however, circling only minimums may be authorized if the maximum circling descent gradient is not exceeded (see Para 252.d). In these cases, publish the actual descent gradient to threshold crossing height (TCH) rather than to circling minimum descent altitude (CMDA).

   a. Non-RNAV approaches. FAF and/or last SDF) location and altitude should be selected to provide a descent angle and TCH coincident (±0.20°, ±3’) with the lowest published visual glideslope indicator (VGSI) glideslope angle, when feasible; or, when VGSI is not installed, the FAF and/or last SDF location and altitude should be selected so as to achieve a near OPTIMUM final segment descent gradient. To determine the FAF or SDF altitude necessary to align the descent angle with the lowest VGSI, calculate the altitude gain of a plane with the slope of the lowest published VGSI glideslope angle emanating from the lowest published VGSI TCH to the FAF or SDF location. To determine the OPTIMUM FAF or SDF altitude, calculate the altitude gain of a 318 FT/NM gradient (3° angle) extending from the visual TCH to the FAF or SDF location. Round this altitude up or down to the 100' increment for the FAF or 20' increment for the SDF. Ensure that ROC requirements are not violated during the rounding process. If the gradient from TCH to SDF is greater than the gradient from TCH to FAF, continue the greater gradient to the FAF and adjust the FAF altitude accordingly. If application of hold-in-lieu of PT criteria in Para 234.e.1, or intermediate segment obstacles prohibit this altitude, consider relocating the FAF to achieve an altitude that will satisfy both the VGSI or OPTIMUM descent gradient (see Figure 2-14-8).

   b. Reserved.
c. Determining Final Segment Descent Gradient and Angle.

(1) **Final Without SDF’s.** Calculate the final descent gradient by dividing the height loss from FAF to TCH by the segment length in NM.

\[
\text{Descent Gradient} = \frac{\text{Height Loss}}{\text{Segment Length (NM)}}
\]

The descent gradient divided by 6076.11548 is the arc tangent of the segment descent angle (\(\theta\)).

\[
\tan(\theta)^{-1} = \frac{\text{Descent Gradient}}{6076.11548}
\]

For RNAV standard instrument approach procedures (SIAP), this angle is the glideslope computer setting.

(2) **Final With SDF.** The maximum descent angle is calculated using the difference between the FAF/stepdown altitudes and the stepdown/TCH altitudes as appropriate. Descent gradient and angle computations apply to each stepdown segment. Height loss in the last segment flown is from the SDF minimum altitude to the TCH (see Figure 2-14-10).

d. **Circling Approaches.** The maximum descent angle is calculated using the difference between the FAF/stepdown altitudes and stepdown/lowest CMDA as appropriate (see Figure 2-14-11).

253—259. Reserved

---

**Figure 2-14-7: Final End Point. Para 252.**
EXAMPLE

Givens:

 THR elevation is 1,012'
 TCH is 46'
 Final Segment length is 4.78 NM

Where

 THRe = THR Elevation (ft)
 SL = Segment Length

Solution:

1. SL in **NM**

   FAF Altitude = THRe + TCH + (318 x SL)
   FAF Altitude = 1012 + 46 + (318 ft/NM x 4.78 NM) = **2578.04 ft**

2. SL in **feet**

   FAF Altitude = THRe + TCH + (Tan (VGSI Angle) x SL X 6076.11548)
   FAF Altitude = 1012 + 46 + (Tan (3) x 4.78 x 6076.11548) = **2580.12 ft**

Figure 2-14-8: FAF Activities Given Final Length. Para 252.a.
**EXAMPLE**

**Givens:**
- Descent Gradient Plane is 3°
- THR elevation is 1,012'
- TCH is 46'
- FAF Altitude is 2600'

**Where**
- SL = Segment Length (ft)
- THRe = THR Elevation (ft)
- TCH = Threshold Crossing Height (ft)
- SL = Segment Length
- DGP = Descent Gradient Plane
- VGSI = Visual Ground Slope Indicator
- FAF<sub>ALT</sub> = FAF Altitude

\[
SL = \frac{(FAF_{ALT} - [THRe + TCH])}{\tan(DGP \text{ or } VGSI)}
\]

\[
SL = \frac{(2600 - [1012 + 46])}{\tan(3°)}
\]

\[
SL = 29423.11
\]

**Figure 2-14-9: Final Length Given FAF Altitude. Para 252.b.**
**FAF to SDF**

Descent gradient computation:

\[
\text{Descent}_{\text{GRADIENT}} = \frac{(1600 - 980)}{3.0} = \frac{620}{3.0} = 206.6667
\]

Descent Gradient = 207 ft/NM

\[
\tan(\theta) - 1 = \frac{207}{6076.11548}
\]

\[
\theta = 1.95^\circ
\]

Angle is 1.95°

**SDF to TCH**

Descent gradient computation:

\[
\text{Descent}_{\text{GRADIENT}} = \frac{980 - (453 + 46)}{1.5} = \frac{481}{1.5} = 320.6667
\]

Descent Gradient = 321 ft/NM

\[
\tan(\theta) - 1 = \frac{321}{6076.11548}
\]

\[
\theta = 3.02^\circ
\]

Angle is 3.02°

---

**Figure 2-14-10: Descent Gradient And Angle. Para 252.c.(2).**
To calculate Descent Gradient and Angle given a FAF altitude and final length

\[
\text{Descent Gradient} = \frac{2900 - 1320}{4.78}
\]

\[
\text{Descent Gradient} = \frac{1580}{4.78} = 330.54393
\]

Descent Gradient = 331 ft/NM

\[
\tan(\theta)^{-1} = \frac{331}{6076.11548}
\]

\[
\theta = 3.12^\circ
\]

Angle is 3.12°

Figure 2-14-11: Circling Approach Maximum Descent Angle. Para 252.d.
SECTION 6. CIRCLING APPROACH

260. Circling Approach Area

This is the obstacle clearance area, which shall be considered for aircraft maneuvering to land on a runway, which is not aligned with the FAC of the approach procedures, or for an approach where the final segment descent gradient does not meet criteria.

a. Alignment and Area. The size of the circling area varies with the approach category of the aircraft, as shown in Table 2-4. To define the limits of the circling area for the appropriate category, draw an arc of suitable radius from the centre of the end of each usable runway. Join the extremities to the adjacent arcs with lines drawn tangent to the arcs. The area thus enclosed is the circling approach area (see Figure 2-15).

<table>
<thead>
<tr>
<th>Approach Category</th>
<th>Radius (NM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.3</td>
</tr>
<tr>
<td>B</td>
<td>1.5</td>
</tr>
<tr>
<td>C</td>
<td>1.7</td>
</tr>
<tr>
<td>D</td>
<td>2.3</td>
</tr>
<tr>
<td>E</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Table 2-4: Circling Approach Area Radii (NM). Para 260a.

b. Obstacle Clearance. A minimum of 300 feet of obstacle clearance shall be provided in the circling approach area. There is no secondary obstacle clearance for the circling approach. See Para 322 for standard circling MDA.

261. Circling Approach Area Not Considered For Obstacle Clearance

It is permissible to eliminate from consideration, a particular sector where prominent obstacles exist in the circling approach area, provided the landing can be made without maneuvering over this sector and further provided that a note to this effect is included in the procedure. When a sector is eliminated from the obstacle clearance area, the area within which circling is permitted will be expanded to include a portion of the sector eliminated. The expanded portion of the obstacle clearance area shall begin at the threshold and splay 10° from the runway edge. Sectors within which circling is not permitted shall be clearly identified by runway centrelines, and where necessary, illumination of certain runway lights may be required. Circling restrictions shall be noted on the procedure.

262—269. Reserved
Radii (R). Defining size of areas vary with approach category.

Figure 2-15: Construction Of Circling Approach Area. Para 260.a.
SECTION 7. MISSED APPROACH

270. Missed Approach Segment

(See ILS and PAR chapters for special provisions). A missed approach procedure shall be established for each IAP. The missed approach shall be initiated at the decision height (DH) in precision approaches or missed approach point (MAP) in non-precision approaches. The missed approach procedure must be simple, specify an altitude, and a clearance limit. The missed approach altitude specified in the procedure shall be sufficient to permit holding or en route flight. This means that the missed approach altitude must provide sufficient ROC to allow the pilot to hold at the missed approach holding fix (using the appropriate holding template), or must provide sufficient ROC to allow the pilot to proceed enroute. Where the missed approach altitude is below an initial approach altitude or enroute altitude, the 40:1 OIS must be assessed beyond the missed approach holding fix. If a climb in hold is required, it shall be assessed in accordance with Chapter 18, Holding Criteria. A note indicating that a shuttle is required prior to proceeding on course shall be included in the missed approach instructions. Example: Shuttle climb to 5000' BPOC.

Design alternate missed approach procedures using the criteria in this section. The area considered for obstacles has a width equal to that of a final approach area at the MAP and expands uniformly to the width of the initial approach segment at a point 15 nautical miles from the MAP (see Figure 2-16). When PCG is available, a secondary area for the reduction of obstacle clearance is identified within the missed approach area, which has the same width as the final approach segment area at the MAP, and which expands uniformly to a width of 2 NM at a point 15 NM from the MAP (see Figure 2-16). Where PCG is not available beyond this point, expansion of the area continues until PCG is achieved or segment terminates. Where PCG is available beyond this point, the area tapers at a rate of 30° inward relative to the course until it reaches initial segment width.

Note: Only the primary missed approach procedure shall be included on the published chart.

271. Missed Approach Alignment

Wherever practical, the missed approach course should be a continuation of the FAC. Turns are permitted, but should be minimized in the interest of safety and simplicity.

272. Missed Approach Point (MAP)

The MAP specified in the procedure may be the point of intersection of an electronic glide path with a DA, a navigation facility, a fix, or a specified distance from the FAF. The specified distance may not be more than the distance from the FAF to the usable landing surface. Specific criteria for the MAP are contained in the appropriate facility chapters.

273. Straight Missed Approach Area

When the missed approach course is within 15° of the final approach course, it is considered a straight missed approach (see Figure 2-16). The area considered for obstacle clearance is specified in Para 270.
Figure 2-16: Straight Missed Approach Area. Para 273.

Figure 2-17: Straight Missed Approach Obstacle Clearance. Para 274.

Figure 2-18: Missed Approach Cross-Section. Para 274.
274. Straight Missed Approach Obstacle Clearance

Within the primary missed approach area, no obstacle shall penetrate the missed approach surface. This surface begins over the MAP at a height determined by subtracting the required final approach primary area ROC and any minima adjustments, in accordance with Para 323, from the MDA. It rises uniformly at a rate of 1 foot vertically for each 40 feet horizontally (40:1) (see Figure 2-17). Where the 40:1 surface reaches a height of 1,000 feet below the missed approach altitude (Para 270), further application of the surface is not required. In the secondary area, no obstacle shall penetrate a 12:1 slope that extends outward and upward from the 40:1 surface at the inner boundaries of the secondary area (see Figure 2-18). Evaluate the missed approach segment to ensure obstacle clearance is provided.

a. Evaluate the 40:1 surface from the MAP to the clearance limit (end of the missed approach segment). The height of the missed approach surface over an obstacle is determined by measuring the straight-line distance from the obstacle to the nearest point on the line defining the origin of the 40:1 surface. If obstacles penetrate the surface, take action to eliminate the penetration.

b. The preliminary charted missed approach altitude is the highest of the minimum missed approach obstruction altitude, minimum holding altitude (MHA) established in accordance with Para 1820.a, or the lowest airway minimum en route altitude (MEA) at the clearance limit. To determine the minimum missed approach obstruction altitude for the missed approach segment, identified the highest obstacle in the primary area; or if applicable, the highest equivalent obstacle in the secondary area. Then add the appropriate ROC (plus adjustments), for holding or en route to the highest obstacle elevation. Round the total value to the nearest hundred-foot value, provided the ROC is not penetrated.

c. Determine if a climbing in holding pattern (climb-in-hold) evaluation is required (see Para 1822). If a climb in hold is intended at the clearance limit, a climb-in-hold evaluation is mandatory.

(1) Calculate the elevation of the 40:1 surface at the end of the segment (clearance limit). The 40:1 surface starts at the same elevation as it does for obstacle evaluations. Compute the 40:1 rise from a point on the line defining the origin of the 40:1 surface in the shortest distance and perpendicular to the end-of-segment line at the clearance limit.

(2) Compute the ROC surface elevation at the clearance limit by subtracting the appropriate ROC (plus adjustments) from the preliminary charted missed approach altitude.
(3) Compare the ROC surface elevation at the clearance limit with the 40:1 surface elevation.

(a) If the computed 40:1 surface elevation is equal to or greater than the ROC surface elevation, a climb-in-hold evaluation is NOT required.

(b) If computed 40:1 surface elevation is less than the ROC surface elevation, a climb-in-hold evaluation IS required. TP308/GPH209, Chapter 18, Holding Pattern Criteria, Para 1820 specifies higher speed groups and, therefore, larger template sizes are usually necessary for the climb-in-hold evaluation. These templates may require an increase in minimum holding altitude (MHA) under TP308/GPH209 Chapter 18, Para 1801.c. Minimum Holding Altitude (MHA). If this evaluation requires an increase in the MHA, evaluate the new altitude using the higher speed group specified in Para 1822. This sequence of review shall be used until the MHA does not increase, then the 40:1 surface is re-evaluated. If obstacles penetrate the 40:1 surface, take action to eliminate the penetration.

(c) The charted missed approach altitude is the higher of the preliminary charted missed approach altitude or the MHA established under Para 274.c.3.b.

<table>
<thead>
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<th>Flightpath Radius (R₁)</th>
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<td>D</td>
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<tr>
<td>E</td>
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<td>2.50</td>
</tr>
</tbody>
</table>

Table 2-5: Turning Missed Approach Radii (Nautical Miles). Para 275.
275. Turning Missed Approach Area

(See Volume 3 for special provisions.) If a turn of more than 15° from the FAC is required, a turning missed approach area must be constructed.

**Note:** If the HAT value associated with the DH/MDA is less than 400 feet, construct a combination straight and turning missed approach (see Para 277) to accommodate climb to at least 400 feet above the TDZE or Airport elevation prior to turn.

a. The dimensions and shape of this area are affected by three variables:

1. Width of final approach area at the MAP.
2. All categories of aircraft authorized to use the procedure (the obstacle area for each aircraft category, authorized to fly the procedure, shall be assessed); and
3. Number of degrees of turn required by the procedure.

b. Secondary areas for the reduction of obstacle clearance are permitted when PCG is provided. The secondary area begins where a line perpendicular to the straight flightpath, originating at the point of completion of the turn, intersects the outer boundaries of the missed approach segment. The width of the secondary area expands uniformly from 0 (zero) to 2 NM at the 15 NM flight track point.

c. Primary areas. Figures 2-19 to 2-24 show the manner of construction of some typical turning missed approach areas. The following radii are used in the construction of these areas:

1. 90° Turn or Less. Narrow final approach area at MAP (see Figure 2-19). To construct the area:

   a. Draw an arc with the radius \( R_1 \) from the MAP. This line is then extended outward to a point 15 NM from the MAP, measured along the line. This is the assumed flight path. (see Table 2-5).

   b. Establish Points "A₂" and "B₁" by measuring 6 NM perpendicular to the flight path at the 15 mile point.

   c. Now connect "A₂" and "B₁" with a straight line.

   d. Draw an arc with the radius \( R \) from Point "A₁" to "A₂". ("A₁" is defined as the point where a line from "A₂" becomes tangent to the obstacle clearance "R" radius.) This is the edge of the obstacle clearance area.

   e. Establish Point "B" by measuring backward on the edge of the final approach secondary area a distance of 1 mile or a distance equal to the fix error PRIOR to the FAF, whichever is greater.

   f. Connect Points "A₁" and "A₂", and Points "B" and "B₁" with straight lines.
(2) **90° Turn or Less.** Wide final approach area at MAP (see Figure 2-20). To construct the area:

(a) Draw an arc with the appropriate radius \(R_1\) from the MAP. This line is then extended outward to a point 15 NM from the MAP, measured along the line. This is the assumed flight path.

(b) Establish Points "A\(_2\)" and "B\(_1\)" by measuring 6 NM perpendicular to the flight path at the 15-mile point.

(c) Now connect Points "A\(_2\)" and "B\(_1\)" with a straight line.

(d) Draw an arc with the appropriate radius \(R\) from Point "A\(_2\)" to "A\(_1\)". ("A\(_1\)" is defined as the point where a line from "A\(_2\)" becomes tangent to the obstacle clearance "R" radius.) This is the edge of the obstacle clearance area.

(e) Establish Point "B" by measuring backward on the edge of the final approach secondary area a distance of 1 mile or a distance equal to the fix error PRIOR to the FAF, whichever is greater.

(f) Connect Points "A\(_1\)" and "A\(_2\)" and Points "B" and "B\(_1\)" with straight lines.

(3) **More Than a 90° Turn.** NARROW FINAL approach area at MAP (see Figure 2-21). To construct the area:

(a) Draw an arc with the radius \(R\) from the MAP through the required number of degrees and then continue outward to a point 15 NM from the MAP, measured along this line, which is the assumed flight path.

(b) Establish Points "A\(_2\)" and "C\(_1\)" by measuring 6 NM on each side of the assumed flight path and perpendicular to it at the 15 mile point.

(c) Now connect Points "A\(_2\)" and "C\(_1\)" with a straight line.

(d) Draw an arc with the radius \(R\) from Point "A\(_2\)" to Point "A\(_1\)" (Figure 2-21 uses 135°). ("A\(_1\)" is defined as the point where a line from "A\(_2\)" becomes tangent to the obstacle clearance "R" radius.) This is the outer edge of the obstacle clearance area.

(e) Locate Point "C" at the inner edge of the final approach secondary area opposite the MAP. (Point "A\(_1\)" and Point "C" will be coincident when the MAP is the facility.)

(f) Connect Points "A\(_1\)" and "A\(_2\)" and Points "C" and "C\(_1\)" with straight lines.
(4) More Than 90° Turn. WIDE FINAL approach area at MAP (see Figure 2-22). To construct the area:

(a) Draw the assumed flightpath, which is an arc with the radius (R₁), from the MAP the required number of degrees to the desired flightpath or course.

(b) Establish Points "A₄" and "C₁" by measuring 6 NM on each side of the assumed flight path and perpendicular to it at the 15-mile point.

(c) Connect Points "A₄" and "C₁" with a straight line.

(d) Draw a 90° arc with the appropriate radius (R) from Point "A" to Point "A₁". Note that when the width of the final approach area at the MAP is greater than the appropriate radius (R), the turn is made in two increments when constructing the obstacle clearance area.

(e) Draw an arc with the radius (R) from Point "D" (edge of final approach secondary area opposite MAP) the required number of degrees from Point "A₂" to Point "A₃". (Point "A₃" is defined as the point where a line from "A₄" becomes tangent to the obstacle clearance "R" radius from Point "D"). Compute the number of degrees by subtracting 90° from the total turn magnitude.

(f) Connect Points "A₁" and "A₂" with a straight line.

(g) Locate Point "C" at the inner edge of the final approach secondary area opposite the MAP.

(h) Connect Point "A₃" with Point "A₄" and connect Point "C" with Point "C₁" using straight lines.

(5) 180° Turn. Narrow final approach area at MAP (see Figure 2-23). To construct the area:

(a) Draw an arc with the radius (R₁) from the MAP through 180°, and then continue outward to a point 15 NM from the MAP, measured along this line, which is the assumed flight path.

(b) Establish Points "A₂" and "C₁" by measuring 6 NM on each side of the assumed flight path, and perpendicular to it at the 15 mile point.

(c) Now connect Point "A₂" and Point "C₁" with a straight line.

(d) Locate Point "C" at the inner edge of the final approach secondary area opposite the MAP. (Point "A" and Point "C" will be coincident when the MAP is the facility.)

(e) Draw an arc with the radius (R) from Point "A" to Point "A₁" (180°). This is the outer edge of the obstacle clearance area.

(f) Connect Points "A₁" and "A₂" and Points "C" and "C₁" by straight lines. (The line "A₁-A₂" joins the arc tangentially.)
(6) 180° Turn. Wide Final Approach area at MAP (see Figure 2-24). To construct the area:

(a) Draw the flightpath arc with the radius \( R_1 \) from the MAP and then continue the line outward to a point 15 NM from the MAP, measured along the assumed flightpath.

(b) Establish Points "A_4" and "C_1" by measuring 6 NM on each side of the flight path and perpendicular to it at the 15-mile point.

(c) Now connect Points "A_4" and "C_1" with a straight line.

(d) Draw a 90° arc with the appropriate radius \( R \) from Point "A" to Point "A_1". Note that when the width of the final approach area at the MAP is greater than the appropriate radius \( R \), the turn is made in two increments when constructing the obstacle clearance area.

(e) Draw an arc with the radius \( R \) from Point "D" (edge of final approach secondary area opposite MAP) the required number of degrees from Point "A_2" to Point "A_3". Compute the number of degrees by subtracting 90° from the total turn magnitude.

(f) Connect Points "A_1" and "A_2" with a straight line.

(g) Locate Point "C" at the inner edge of the final approach secondary area opposite the MAP.

(h) Connect Points "A_3" and "A_4" and Points "C" and "C_1" with straight lines. (The line "A_3-A_4" joins the arc tangentially.)
Figure 2-19: Turning Missed Approach Area. 90 Degree Turn Or Less. Narrow Final Approach At MAP. Para 275.c.(1).
Figure 2-20: Turning Missed Approach Area. 90 Degree Turn Or Less. Wide Final Approach Area At MAP. Para 275.c.(2).
Figure 2-21: Turning Missed Approach Area. More Than 90 Degree Turn. Narrow Final Approach At MAP. Para 275.c.(3).
Figure 2-22: Turning Missed Approach Area. More Than 90 Degree Turn. Wide Final Approach At MAP. Para 275.c.(4).
Figure 2-23: Turning Missed Approach Area. 180 Degree Turn. Narrow Final Approach Area At MAP. Para 275.
Figure 2-24: Turning Missed Approach Area. 180-Degree Turn. Wide Final Approach Area At MAP. Para 275.c.(6).
276. Turning Missed Approach Obstacle Clearance

The methods of determining the height of the 40:1 missed approach surface over obstacles in the turning missed approach area vary with the amount of turn involved. Evaluate the missed approach segment to ensure the 40:1 obstacle identification surface (OIS) is not penetrated.

a. **90° Turn or Less** (see Figure 2-25). Zone 1 is a 1.6-mile continuation of the final approach secondary area, and has identical obstacle clearance requirements. Zone 2 is the area in which the height of the missed approach surface over an obstacle must be determined. To do this, first identify line "A-D-B". Point "B" is located by measuring backward on the edge of the final approach area a distance of 1 mile or a distance equal to the fix error prior to the MAP, whichever is greater. This is to safeguard the short-turning aircraft. Thus, the height of the missed approach surface over an obstacle in Zone 2 is determined by measuring the straight-line distance from the obstacle to the nearest point on line "A-D-B" and computing the height based on the 40:1 ratio. The height of the missed approach surface over the MAP is the same as specified in Para 274. When an obstacle is in a secondary area, measure the straight-line distance from the nearest point on the line "A-D-B" to the point on the inner edge of the secondary area which is nearest the obstacle. Compute the height of the missed approach surface at this point, using the 40:1 ratio. Then apply the 12:1 secondary area ratio from the height of the surface for the remaining distance to the obstacle.

b. **More than 90° Turn** (see Figure 2-26). In this case a third zone becomes necessary. Zone 3 is defined by extending a line from Point "B" to the extremity of the missed approach area perpendicular to the FAC. Zone 3 will encompass all of the missed approach area not specifically within Zones 1 and 2. All distance measurements in Zone 3 are made from point "B". Thus the height of the missed approach surface over an obstacle in Zone 3 is determined by measuring the distance from the obstacle to point "B" and computing the height based on the 40:1 ratio. The height of the missed approach surface over Point "B" for Zone 3 computations is the same as the height of the MDA. For an obstacle in the secondary area, use the same measuring method prescribed in Para 276.a except that the original measuring point shall be point "B".

c. **Secondary Area**. In the secondary area no obstacles may penetrate a 12:1 slope, which extends outward and upward from the 40:1 surface from the inner to the outer boundary lines of the secondary area.

d. **Evaluate** the missed approach segment from the MAP to the clearance limit. Terminate the 40:1 obstacle clearance surface (OCS) at an elevation corresponding to enroute ROC below the missed approach altitude.

(1) If the 40:1 OCS terminates prior to the clearance limit, continue the evaluation using a level OIS at the height that the 40:1 OCS was terminated.

(2) If the clearance limit is reached before the 40:1 OCS terminates, continue a climb-in-hold evaluation at the clearance limit.

e. The preliminary charted missed approach altitude is the highest of the minimum missed approach obstruction altitude, MHA established in accordance with Chap 18, Para 1820.c, or lowest airway MEA at the clearance limit. To determine the minimum missed approach obstruction altitude for the missed approach segment, identify the highest obstacle in the primary area; or if applicable, the highest equivalent obstacle in the secondary area. Then add the appropriate ROC (plus adjustments) for holding or en route to the highest obstacle elevation. Round the total value to the nearest hundred-foot level, provided the ROC is not violated.
f. **Determine** if a climb-in-hold evaluation is required (see Chap 18, Para 1822.a(2)).

   (1) Calculate the elevation of the 40:1 surface at the end of the segment (clearance limit). The 40:1 surface starts at the same elevation as it does for obstacle evaluations. Compute the 40:1 rise from a point on the “A-D-B” line in the shortest distance to the end-of-segment line at the clearance limit.

   (2) Compute the ROC surface elevation at the clearance limit by subtracting the appropriate ROC (plus adjustments) from the preliminary charted missed approach altitude.

   (3) Compare the ROC surface elevation at the clearance limit with the 40:1 surface elevation.

      (a) If the computed 40:1 surface elevation is equal to or greater than the ROC surface elevation, a climb hold evaluation is NOT required, or

      (b) If the computed 40:1 surface elevation is less than the ROC surface elevation, a climb-in-hold evaluation IS required. Chap 18 Holding Criteria, Para 1822, specifies higher speed groups and therefore, larger template sizes are usually necessary for the climb-in-hold evaluation. These templates may require an increase in MHA under Para 1801.c. If this evaluation requires an increase in the MHA, evaluate the new altitude using the higher speed group specified in Para 1822. This sequence of review shall be used until the MHA does not increase, then the 40:1 surface is re-evaluated. If obstacles penetrate the 40:1 surface, take action to eliminate the penetration.

   g. The charted missed approach altitude is the higher of the preliminary charted missed approach altitude or the MHA established under Para 274.c.3.b.

277. Combination Straight And Turning Missed Approach Area

If a straight climb to a specific altitude followed by a turn is necessary to avoid obstacles, a combination straight and turning missed approach area must be constructed. The straight portion of this missed approach area is Section 1. The portion in which the turn is made is Section 2. Evaluate the missed approach segment to ensure obstacle clearance is provided.

   a. **Straight Portion.** Section 1 is a portion of the normal straight missed approach area and is constructed as specified in Para 273. Obstacle clearance is provided as specified in Para 274 except that secondary area reductions do not apply. The length of Section 1 is determined as shown in Figure 2-27 and relates to the need to climb to a specified altitude prior to commencing the turn. Point A₁ marks the end of Section 1. Point B₁ is one nautical mile from the end of Section 1 (see Figure 2-27).

   b. **Turning Portion.** Section 2 is constructed as specified in Para 275 except that it begins at the end of Section 1 instead of at the MAP. To determine the height, which must be attained before commencing the missed approach turn, first identify the controlling obstacle on the side of Section 1 to which the turn is to be made. Then measure the distance from this obstacle to the nearest edge of the Section 1 area. Using this distance as illustrated in Figure 2-27, determine the height of the 40:1 slope at the edge of Section 1. This height plus the appropriate final ROC, (the sum rounded up to the next higher 100-foot increment) is the height at which the turn should be started. Obstacle clearance requirements in Section 2 are the same as those specified in Para 276 except that Zone 1 is not considered and Section 2 is expanded to start at point “B” if no fix exists at the end of Section 1, or if no course guidance is provided in Section 2 (see Figure 2-27).
c. **Evaluate** the 40:1 surface from the MAP to the clearance limit (end of the missed approach segment). If obstacles penetrate the surface, take action to eliminate the penetration.

d. The preliminary charted missed approach altitude is the lowest of the minimum missed approach obstruction altitude, MHA established in accordance with Chapter 18, Para 1820.c, or lowest airway MEA at the clearance limit. To determine the minimum missed approach obstruction altitude for the missed approach segment, identify the highest obstacle in the primary area; or if applicable, the highest equivalent obstacle in the secondary area. Then add the appropriate ROC (plus adjustments) for holding or en route to the highest obstacle elevation. Round the total value to the next higher hundred-foot level.

e. **Determined** if a climb-in-hold evaluation is required (see Chapter 18, Para 1822).

(1) Calculate the elevation in the 40:1 surface at the end of the segment (clearance limit). The 40:1 surface starts at the same elevation as it does for obstacle evaluations, plus minima adjustments in accordance with Para 323.

(2) Compute the ROC surface elevation at the clearance limit by subtracting the appropriate ROC (plus adjustments) from the preliminary charted missed approach altitude.

(3) Compare the ROC surface elevation at the clearance limit with the 40:1 surface elevation.

   (a) If the computed 40:1 surface elevation is equal to or greater than the ROC surface elevation, a climb-in-hold evaluation is NOT required.

   (b) If the computed 40:1 surface elevation is less than the ROC surface elevation, a climb-in-hold evaluation IS required. TP 308 Holding Criteria, Para 1822, specifies higher speed groups and therefore, larger template sizes are usually necessary for the climb-in-hold evaluation. These templates may require an increase in MHA under Para 1801.c. If this evaluation requires an increase in the MHA, evaluate the new altitude using the higher speed group specified in Para 1822. This sequence of review shall be used until the MHA does not increase, then the 40:1 surface is re-evaluated. If obstacles penetrate the 40:1 surface, take action to eliminate the penetration.

f. The charted missed approach altitude is the higher of the preliminary charted missed approach altitude or the MHA established under Para 274.c.3.b.

278. **End of Missed Approach**

Aircraft shall be assumed to be in the initial approach or en route environment upon reaching minimum obstacle clearance altitude (MOCA) or minimum en route altitude (MEA). Thereafter, the initial approach or the en route obstacle clearance criteria apply. This means that the missed approach altitude must provide sufficient ROC to allow the pilot to hold at the missed approach holding fix (using the appropriate holding template), or must provide sufficient ROC to allow the pilot to proceed enroute. Where the missed approach altitude is below an initial approach altitude or enroute altitude, the 40:1 OIS must be assessed beyond the missed approach holding fix. If a climb in hold is required, it shall be assessed in accordance with Chapter 18, Holding Criteria. A note indicating that a shuttle is required prior to proceeding on course shall be included in the missed approach instructions. Example: Shuttle climb to 5000' BPOC.
Figure 2-25: Turning Missed Approach Obstacle Clearance. 90 Degree Turn Or Less. Para 276.
Figure 2-26: Turning Missed Approach Obstacle Clearance. More Than 90 Degree Turn. Para 276.
Example

Given:
1. MDA .................. 360’ MSL
2. Obstacle height .......... 1098’ MSL
3. Obstacle is section 2, 3 NM from near edge of section 1

Find:
1. Require length of Section 1
2. Minimum altitude at which aircraft can start turn

Solution:
1. Find height MSL at near edge
   ObstHt – (Dist x 6076 / 40)
   1098 – (3 x 6076 / 40) = 642’
2. Find HMAS
   HMAS = MDA – (ROC + Adjustments)
   HMAS = 360 – 250 = 110’
3. Find the rise from MAP to the end of Section 1
   642 – 110 = 532’

Answer 1:
- Length of Section 1 = 532 x 40 = 21,280 feet (* see note)

Answer 2:
- Minimum altitude at which aircraft can turn: (21280 / 6076) x 200) + 360 = 1060’ MSL
- Round results to next higher 100 foot increment
- Missed approach instructions: “Climb to 1100’ before starting right turn to…”

Notes:
1. “Section 1 must be lengthened to accommodate the rounding up to 1100’. In this example, the aircraft will climb an extra 40’ (from 1060’ to 1100’) at 200’/NM, therefore traveling an extra 1200’ (40x30) from the previous section 1 calculation. The required length of section 1 for the turn at 1100’ MSL is 22,480 (21280 + 1200)

Notes:
2. Line BC becomes the boundary of Section 2 if:
   - No Fix exists at the end of section 1, or
   - No course guidance is provided in Section 2

Figure 2-27: Combined Missed Approach Area. Para 277.a.
279. Missed Approach Climb Gradient

Where the OCS is penetrated and the lowest minima is required, a missed approach climb gradient (CG) greater than the standard 200 ft/NM (or 400 ft/NM for COPTER procedures) may be specified. Gradients greater than 425 ft/NM (or 600 ft/NM for COPTER procedures) require Flight Standards approval.
SECTION 8. TERMINAL AREA FIXES

280. General
Terminal area fixes include, but are not limited to the FAF, the IF, the IAF, the holding fix, and when possible, a fix to mark the MAP. Each fix is a geographical position on a defined course. Terminal area fixes should be based on similar navigation systems. For example, TACAN, VORTAC, and VOR/DME facilities provide Radial/DME fixes. NDB facilities provide bearings. VOR facilities provide VOR radials. The use of integrated (VHF/NDB) fixes shall be limited to those intersection fixes where no satisfactory alternative exists.

281. Fixes Formed By Intersection
A geographical position can be determined by the intersection of courses or radials from two stations. One station provides the course the aircraft is flying and the other provides a crossing indication that identifies a point along the course that is being flown. Because all stations have accuracy limitations, the geographical point which is identified is not precise, but may be anywhere within a quadrangle which surrounds the plotted point of intersection. Figure 2-28 illustrates the intersection of an arc and a radial from the same DME facility, and the intersection of two radials or courses from different navigation facilities. The area encompassed by the sides of the quadrangle formed in these ways is referred to in this publication as the "fix displacement area".

282. Course/Distance Fixes
A DME fix is formed by a DME reading on a positive navigational course. The information should be derived from a single facility with collocated azimuth and DME antennas. However, when a unique operational requirement indicates a need for DME information from other than collocated facilities, an individual IAP that specifies DME may be approved, provided the angular divergence between the signal sources at the fix does not exceed 23° (see Figure 2-28). For limitation on use of DME with ILS, see Volume 3, Para 2.9.1.

283. Fixes Formed By Radar
Where ATC can provide the service, Airport Surveillance Radar (ASR) may be used for any terminal area fix. PAR may be used to form any fix within the radar coverage of the PAR system. Air Route Surveillance Radar (ARSR) may be used for initial approach and intermediate approach fixes.

284. Fix Displacement Area
The areas portrayed in Figure 2-28 extend along the flight course from Point "A" to Point "C". The fix error is a plus-or-minus value, and is represented by the lengths from "A" to "B" and "B" to "C". Each of these lengths is applied differently. The fix error may cause the fix to be received early (between "A" and "B"). Because the fix may be received early, protection against obstacles must be provided from a line perpendicular to the flight course at point "A".
Figure 2-28: Intersection Fix Displacement. Paras 281, 282, and 284.
285. Intersection Fix Displacement Factors

The intersection fix displacement area is determined by the system use accuracy of the navigation fixing systems (see Figure 2-28). The system use accuracy in VOR and TACAN type systems is determined by the combination of ground station error, airborne receiving system error, and flight technical error (FTE). En route VOR data have shown that the VOR system accuracy along radial 4.5°, 95 percent of occasions, is a realistic, conservative figure. Thus, in normal use of VOR or TACAN intersections, fix displacement factors may conservatively be assessed as follows:

a. Along-Course Accuracy.
   (1) VOR/TACAN radials, plus-or-minus 4.5°.
   (2) Localizer course, plus-or-minus 1°.
   (3) NDB courses or bearings, plus-or-minus 5°.

   Note: The plus-or-minus 4.5° (95 percent) VOR/TACAN figure is achieved when the ground station course signal error, the FTE, and the VOR airborne equipment error are controlled to certain normal tolerances. Where it can be shown that any of the three error elements is consistently different from these assumptions (for example, if flight inspection shows a consistently better VOR signal accuracy or stability than the one assumed, or if it can be shown that airborne equipment error is consistently smaller than assumed), VOR fix displacement factors smaller than those shown above may be utilized under Para 141.

b. Crossing Course Accuracy.
   (1) VOR/TACAN radials, plus-or-minus 3.6°.
   (2) Localizer course, plus-or-minus 0.5°.
   (3) NDB courses or bearings, plus-or-minus 5°.

   Note: The plus-or-minus 3.6° (95 percent) VOR/TACAN figure is achieved when the ground station course signal error and the VOR airborne equipment error are controlled to certain normal tolerances. Since the crossing course is not flown, FTE is not a contributing element. Where it can be shown that either of the error elements is consistently different, VOR displacement factors smaller than those shown above may be utilized in accordance with Para 141.

286. Other Fix Displacement Factors

a. Radar. Plus-or-minus 500 feet or 3 percent of the distance to the antenna, whichever is greater.

b. DME. Plus-or-minus 0.25 NM plus 0.0125 of the distance to the antenna.

c. Overheading a Station. The fix error involved in station passage is not considered significant in terminal applications. The fix is therefore considered to be at the plotted position of the navigation facility. The use of TACAN station passage as a fix is NOT acceptable for holding fixes or high altitude IAF’s.
287. Satisfactory Fixes

a. Intermediate, Initial or Feeder Fix. To be satisfactory as an intermediate or initial or feeder approach fix, the fix error must not be larger than 50 percent of the appropriate segment distance that follows the fix. Measurements are made from the plotted fix position (see Figure 2-29).

b. Holding Fixes. Any terminal area fix except overheading a TACAN may be used for holding. The following conditions shall exist when the fix is an intersection formed by courses or radials:

(1) The angle of divergence of the intersecting courses or radials shall not be less than 45°.

(2) If the facility that provides the crossing course, is NOT an NDB, it may be as much as 45 NM from the point of intersection.

(3) If the facility that provides the crossing course is an NDB, it must be within 30 NM of the intersection point.

(4) If distance stated in Para 287.b.(2) or (3) are exceeded, the minimum angle of divergence of the intersecting courses must be increased at the following rate:

(a) If an NDB facility is involved, 1° for each mile over 30 NM.

(b) If an NDB facility is NOT involved, ½° for each mile over 45 NM.

c. FAF. For a fix to be satisfactory for use as a FAF, the fix error should not exceed plus-or-minus 1 mile (see Figures 2-31-1 and 2-31-2). It may be as large as plus-or-minus 2 NM when:

(1) The MAP is marked by overheading an air navigation facility; OR

(2) A buffer of equal length to the excessive fix error is provided between the published MAP and the point where the missed approach surface begins (see Figure 2-32)
Figure 2-29: Intermediate, Initial, or Feeder Approach Fix Errors. Para 287.

**Note:** B segment from IF to FAF.

Figure 2-31-1: Measurement Of FAF Error. Para 287.c.
288. Using Fixes For Descent

a. Distance Available for Descent. When applying descent gradient criteria applicable to an approach segment (initial, intermediate or final approach areas), the measuring point is the plotted position of the fix (see Figure 2-33).

b. Obstacle Clearance After Passing a Fix. It is assumed that descent will begin at the earliest point the fix can be received. Full obstacle clearance shall be provided from this point to the plotted point of the next fix. Therefore, the altitude to which descent is to be made at the fix must provide the same clearance over obstacles in the fix displacement area as it does over those in the approach segment that is being entered (see Figures 2-34-1 and 2-34-2).

c. Step-down Fixes (see Figure 2-35).

(1) DME or Radar Fixes. Except in the intermediate segment within a procedure turn (see Para 244), there is no maximum number of step-down fixes in any segment when DME or radar is used. DME may be denoted in tenths of a mile. The distance between fixes shall not be less than 1 mile.
(2) Intersection Fixes.
   (a) Only one step-down fix is permitted in the final and intermediate segments.
   (b) If an intersection fix forms a FAF, IF, or IAF:
      (i) The same crossing facility shall be used for the step-down fix(es) within that segment.
      (ii) All fixes from the IF to the last step-down fix in final shall be formed using the same crossing facility.
   (c) Table 2-5A shall be used to determine the number of step-down fixes permitted in the initial segment. The distance between fixes shall not be less than 1 mile.

(3) Altitude at the Fix. The minimum altitude at each step-down fix shall be specified in 100-foot increments, except the altitude at the last step-down fix in the final segment may be specified in a 20-foot increment.

(4) In the Final Segment:
   (a) A step-down fix shall not be established unless a decrease of at least 60 feet in MDA or a reduction in the visibility minimum is achieved.
   (b) The last step-down fix error shall not exceed plus-or-minus 2 NM or the distance to the MAP whichever is less. The fix error for other step-down fixes in final shall not exceed 1 NM.
   (c) Minimums shall be published both with and without the last step down fix, except for procedures requiring DME or NDB procedures that use a VOR radial to define the step down fix.

Supplementary Note: Step down fix maybe lower than one or more circling minima.

Figure 2-33: Distance For Descent Gradient Application. Para 288.a.
Figure 2-34-1: Obstacle Clearance Area Between Fixes. Para 288.b.
Figure 2-34-2: Construction Of Fix Displacement Area For Obstacle Clearance. Para 288.b.
289. **Obstacles Close To a FAF or SDF**

Existing obstacles close to a FAF or SDF may be eliminated from consideration if the following conditions are met:

a. The obstacle is in the final approach trapezoid within 1 NM past the point the FAF/SDF can first be received, AND

b. The obstacle does not penetrate the 7:1 obstacle identification surface (OIS). The surface begins at the earliest point the fix can be received and extends toward the MAP 1 NM. The beginning surface height is determined by subtracting the final segment ROC (and adjustments from Para 323., as applicable) from the minimum altitude required at the fix. The surface slopes downward 1 foot vertically for each 7 feet horizontally toward the MAP.

c. Obstacles eliminated from consideration by application of this paragraph shall be noted on the procedure.

The following formulas may be used to determine the OIS height at the obstacle or the minimum fix altitude based on applying the surface to an obstacle, which must be eliminated.

\[
\text{Fix Alt} = \text{MSL altitude at the fix (round up in accordance with Para 288.c.3)}
\]
\[
\text{Obst Dist} = \text{Distance from earliest fix reception to obstacle (ft)}
\]
\[
\text{ROC} = \text{Required Obstacle Clearance (plus adjustments) (ft)}
\]
\[
\text{Obst Elev} = \text{MSL obstacle elevation}
\]

\[
\text{OIS Height} = \text{Fix Alt} - \text{ROC} - \left( \frac{\text{Obst Dist}}{7} \right)
\]
\[
\text{Min Fix Alt} = \text{Obst Elev} + \text{ROC} + \left( \frac{\text{Obst Dist}}{7} \right)
\]

See Figures 2-36a, b and c. To determine fix error, see Para 284, 285, and 286.

**Supplementary Note:** Round \( \frac{\text{OBST DIST}}{7} \) up to next foot.
<table>
<thead>
<tr>
<th>Length of Segment</th>
<th>Number of Fixes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 – 10 NM</td>
<td>1 stepdown fix</td>
</tr>
<tr>
<td>over 10 – 15 NM</td>
<td>2 stepdown fixes</td>
</tr>
<tr>
<td>over 15 NM</td>
<td>3 stepdown fixes</td>
</tr>
</tbody>
</table>

Table 2-5A: Stepdown Fixes In Initial Segment. Para 288c(2)(c).

Figure 2-35: Final Segment Step down Fix, Para 288c.
Obstacles close to a fix (FAF or stepdown) may be eliminated from consideration as an obstacle when the following conditions exist:

1. Must be located in the final approach area, within 1 mile past the point where the fix can be first received,

2. Obstacle does not penetrate a 7:1 descent gradient, which starts at the point where the fix is first received. (7:1 means 1 foot vertically for each 7 feet horizontally.),

3. The height at the start of the 7:1 slope is determined by subtracting the ROC from the minimum altitude required, and

4. Any obstacle eliminated because of the 7:1 descent gradient will be noted on the procedure.

Figure 2-36a: Obstacle Close-In To A Fix. Para 289.
Height at start of 7:1 Slope = MDA – ROC  
= 1,600 – 250 = 1,350’  

Height Loss (ft) of 7:1 slope at d = Dist to Obstacle / 7  
= 2,360 / 7 = 337.143’ (rounded to 338’)  

Height of 7:1 slope at Obstacle = Height at Start – Height Loss  
= 1,350 – 338 = 1,012’  

Obstacle does not penetrate 7:1 slope

Figure 2-36b: Example Of Obstacle Close In To Fix. Para 289.
**Location**: SUMSPOT INTL., AB (CYSS)

**Procedure**: RNAV (GNSS) RWY 02

**Fix**: BEKIE

**Note**: The fix must be located in the final approach area, within 1 mile past the point where the fix can be first received.

### PART I: General

<table>
<thead>
<tr>
<th>Obstacle #</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT &quot;A7&quot;</td>
<td>WT &quot;B3&quot;</td>
<td></td>
</tr>
</tbody>
</table>

### PART II: Obstruction Assessment

<table>
<thead>
<tr>
<th></th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic ROC (before 7:1)</td>
<td>250.00</td>
<td>250.00</td>
</tr>
<tr>
<td>MDA (before 7:1 slope):</td>
<td>1740.00</td>
<td>1740.00</td>
</tr>
<tr>
<td>Adjustments (Vol 1, para 323)</td>
<td>130.00</td>
<td>130.00</td>
</tr>
</tbody>
</table>

| Width of secondary at obstacle (ft) | n/a | 4800.00 |
| Distance (ft) of obstruction in secondary (from edge of primary) | n/a | 3600.00 |

\[ ROC_S = (Basic\ ROC_S + adjust) \times \left(\frac{W_S - d_S}{W_S}\right) \]

\[ ALT_{POIS} = MDA - ROC_P \]
\[ ALT_{SOIS} = MDA - ROC_S \]

\[ ALT_{POIS} = 1360.00 \]
\[ ALT_{SOIS} = 1645.00 \]

| Distance (ft) from start of 7:1 Slope to obstacle | 200.00 | 300.00 |
| Height Loss (ft) of 7:1 slope at d | 28.57 (29.00) | 42.86 (43.00) |

\[ ALT_{slope} = ALT_{POIS} - HL \text{ (and/or)} ALT_{slope} = ALT_{SOIS} - HL \]

\[ ALT_{POIS} = 1331.43 \]
\[ ALT_{SOIS} = 1602.14 \]

| Obstruction Altitude (ASL) | 1209.00 | 1248.00 |
| Clearance = ALT_{slope} - ALT_{obst} | 122.43 | 354.14 |
| Penetration ? (Negative Value = Penetration) | No | No |
| Minimum MDA (before 7:1): For obstacle elimination. | 1617.57 | 1385.86 |

\[ ALT_{obs} + HL + ROC_P \text{ (and/or)} ALT_{obs} + HL + ROC_S \]

| Round Value to next 100 foot value | 1700 | 1400 |

**Figure 2-36c: 7:1 Slope Worksheet (Example)**
INTENTIONALLY LEFT BLANK
CHAPTER 3. TAKE-OFF AND LANDING MINIMA

300. Application

The minima specified in this section are the lowest that can be approved at any location for the type of facility concerned.

301—309. Reserved

SECTION 1. GENERAL INFORMATION

310. Establishment

The minimums established for a particular airport shall be the lowest permitted by the criteria contained in this document. Each procedure shall specify minima for the various conditions stated in the procedure; i.e., straight-in, circling and take-off, as required. The elements of minima are the Minimum Descent Altitude (MDA) or Decision Altitude (DA) and a visibility. The minima shall include the visibility required by the procedure. The height of the MDA or DA above the highest elevation in the touchdown zone (or above the aerodrome elevation for circling approaches) shall be shown on the procedure. Alternate and take-off minima may be specified in separate directives established by the appropriate authority.

311. Publication

Minima shall be published for each approach category that can be accommodated at the aerodrome. Where the aerodrome landing surface is not adequate, or other restrictions exist which prohibit certain approach categories, "Not Authorized" or "NA" shall be entered in lieu of minima values. Approach Category "E" minima should normally be published only on high altitude procedures, except where special requirements exist for their publication on other procedures.

312—319. Reserved
SECTION 2. ALTITUDES

320. Minimum Descent Altitude (MDA)

The MDA is the lowest altitude to which descent shall be authorized in procedures not using a glide slope. The MDA shall be expressed in feet above MSL and is determined by adding the required obstacle clearance to the MSL height of the controlling obstacle in the final approach segment and circling approach area for circling procedures.

321. MDA For Straight-In Approach

The MDA for a straight-in approach shall provide at least the minimum required clearance over obstacles in the final approach segment. It shall also be established high enough to ensure that obstacles in the missed approach area do not penetrate the 40:1 missed approach surface (see Vol 1, Para 274). The MDA shall be rounded up to the next higher 20-foot increment. Example: 2,104 feet becomes 2,120.

322. MDA For Circling Approach

The height of the circling MDA above the aerodrome (HAA) shall not be less than the minima referred to in Para 351. In addition, the MDA shall provide at least the minimum required final obstacle clearance in the final approach segment and the minimum required circling obstacle clearance in the circling approach area. It shall also meet the missed approach requirements specified in Para 321. The MDA shall be rounded to the next higher 20-foot increment. For example, 2,109 feet shall become 2,120. The published circling MDA shall not be above the FAF altitude or below the straight-in MDA.

323. Minima Adjustments

Raising the MDA or DA above that required for obstacle clearance may be necessary under the following conditions:

a. For PA/APV approaches, determine the minimum HATh based on glidpath angle for each aircraft category using table 3-5.

b. Precipitous Terrain. When procedures are designed for use in areas characterized by precipitous terrain, in or outside of designed mountainous areas, consideration must be given to induced altimeter errors and pilot control problems which result when winds of 20 knots or more move over such terrain. Where these conditions are known to exist, required obstacle clearance in the final approach segment should be increased. Procedure specialists and approving authorities should be aware of such hazards involved and make appropriate addition, based on their experience and good judgment, to limit the time in which an aircraft is exposed to lee-side turbulence and other weather phenomena associated with precipitous terrain. This may be done by increasing the minimum altitude over the intermediate and final approach fixes so as to preclude prolonged flight at low altitudes. User comments should be solicited to obtain the best available local information.

Note: An allowance for precipitous terrain should also be considered for initial segments (including dead reckoning) and procedure turns as per paragraphs 232.c, 233.c and 234.c.
c. Remote Altimeter Setting Source (RASS). When the altimeter setting is obtained from a source more than 5 NM from the airport reference point (ARP) for an airport, or the heliport reference point (HRP) for a heliport or vertiport, the ROC shall be increased by the amount of RASS adjustment for the final (except precision final), step-down, circling and intermediate segments. For precision finals, the DH shall be increased by the amount of RASS adjustment. When two altimeter sources are used, RASS shall be applied to the missed approach climb-to-altitude. RASS adjustment does not apply to MSA, initials, en route, feeder routes or segment/areas based upon en route criteria. A remote altimeter-setting source is not authorized for a remote distance that is greater then 75 NM or for an elevation differential between the RASS and the landing area that is greater than 6,000 feet. To determine which adjustment shall apply, evaluate the terrain between the RASS and the airport/heliport/vertiport for adverse atmospheric pressure pattern effects. Comments should be solicited from Environment Canada in order to obtain the best available climatological information.

(1) Where intervening terrain does not adversely influence atmospheric pressure patterns, the following formula shall be used to compute the basic adjustment in feet:

\[
\text{RASS Adjustment} = 2.3 \cdot d_R + 0.14e
\]

where:
- \(d_R\) = the horizontal distance in nautical miles from the altimeter source to the ARP/HRP, and
- \(e\) = the elevation differential in feet between the elevation of the RASS and the elevation of the airport/heliport/vertiport. (see Figure 3-37B).

(2) Where intervening terrain adversely influences atmospheric pressure patterns, an elevation differential area (EDA) shall be evaluated. The EDA is defined as the area within 5 NM each side of a line connecting the ARP/HRP and the RASS, and includes a circular area enclosed by a 5 NM radius at each end of this line. (see Figure 3-37C. The following formulas shall be used to compute the basic adjustment:

\[
\text{RASS Adjustment} = 2.3 \cdot d_R + 0.14E
\]

where:
- \(d_R\) = the horizontal distance in nautical miles from the altimeter source to the ARP/HRP, and
- \(E\) = the terrain elevation differential in feet between the lowest and the highest terrain elevation points contained with the EDA. (see Figure 3-37C).

(3) For the intermediate segment, use 60 per cent of the basic adjustment from Para 323.c (1) or (2), and increase the intermediate segment ROC by the amount this value exceeds 200 feet.

<table>
<thead>
<tr>
<th>Example:</th>
<th>RASS adjustment (100%) = 420 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RASS adjustment (60%) = 420 ft x 0.6 = 252 ft</td>
</tr>
<tr>
<td></td>
<td>Since 60% value is &gt; 200 ft, then:</td>
</tr>
<tr>
<td></td>
<td>Intermediate adjustment = 252 ft – 200 ft = 52 ft</td>
</tr>
<tr>
<td></td>
<td>Therefore</td>
</tr>
<tr>
<td></td>
<td>Primary ROC for intermediate segment = 500 ft + 52 ft = 552 ft</td>
</tr>
</tbody>
</table>
(4) For a missed approach climb-to-altitude when two altimeter sources are available and the climb-to-altitude is less than the missed approach clearance limit altitude, apply RASS adjustment to the climb-to-altitude or to Section 2 and Zone 2/3 40:1 surface height as follows:

(a) Decrease the starting height of the 40:1 surface for Section 2 and Zone 2/3 by the difference between the RASS adjustments for the two remote altimeter sources. (Where one altimeter is local, subtract the full RASS adjustment.) Do not decrease these surface-starting heights to less than the height of the 40:1 surface at the MAP.

(b) If the application of Para 323.c(4)(a) results in a 40:1 surface penetration that cannot be resolved by other methods, provide a second climb-to-altitude using the least accurate altimeter source by adding the difference between the RASS adjustments to the climb-to-altitude and rounding to the next higher 20-foot increment. DO NOT lower the Section 2 and Zone 2/3 40:1 surfaces. This application shall not increase the climb-to-altitude above the missed approach clearance limit altitude.

For example: "MISSED APPROACH: Climb to 5,900 (6,100 when using Kelowna altimeter setting) then ..."

(5) Point-In-Space Approach (PINSA). When the MAP is more than 5 NM from the PINSA altimeter-setting source, RASS adjustment shall be applied. For application of the RASS formula, define "d_R" as the distance from the altimeter setting source to the MAP, and define "e" or "E" as in Para 323.c.(1) or (2).

(6) Minimum Reception Altitude (MRA). Where a minimum altitude is dictated by the MRA, the MRA shall be increased by the amount of the RASS adjustment factor.

(7) When the procedure is based on a remote altimeter source, the procedure shall be annotated, as follows:

(a) Full Time Remote - "Use Ottawa Intl altimeter setting." In this case, the adjustment shall be included in the published altitudes.

(b) Part Time Remote - "When using Ottawa Intl altimeter setting, add XXX feet to all procedure altitudes."

(8) The calculated RASS adjustment value shall be rounded to the nearest 10-foot increment.

**d. Excessive Length of Final Approach.** When a final approach fix is incorporated in the procedure, and the distance from that fix to the nearest landing surface exceeds 6 NM, the required obstacle clearance in the final approach segment shall be increased at the rate of 5 feet for each one-tenth NM over 6 miles. Where a step-down fix is incorporated in the final approach segment, the basic obstacle clearance may be applied between the step-down fix and the MAP, provided the fix is within 6 NM of the landing surface. These criteria are applicable to non-precision approach procedures only.
324. **Decision Altitude (DA)**

The DA applies to approach procedures where the pilot is provided with glidepath deviation information; e.g., ILS, MLS, TLS, LPV, GLS, Baro VNAV, or PAR. The DA is the barometric altitude, specified in feet above MSL, at which a missed approach shall be initiated if the required visual reference has not been established. DA’s shall be established by using the appropriate criteria in this document.

325. **Decision Height (DH)**

The DH is the value of the DA expressed in feet above the highest runway elevation in the touchdown zone. This value is also referred to as **HAT**.

326—329. **Reserved**
Examples:

<table>
<thead>
<tr>
<th>RASS Adjustment — Airport:</th>
<th>RASS Adjustment — Heliport:</th>
</tr>
</thead>
<tbody>
<tr>
<td>RASS = 2.3 $d_R$ + 0.14 $e$</td>
<td>RASS = 2.3 $d_R$ + 0.14 $e$</td>
</tr>
<tr>
<td>= 2.3 (25) + 0.14 (700)</td>
<td>= 2.3 (15) + 0.14 (2300)</td>
</tr>
<tr>
<td>= 57.5 + 98</td>
<td>= 34.5 + 322</td>
</tr>
<tr>
<td>= 155.5 feet</td>
<td>= 356.5 feet</td>
</tr>
</tbody>
</table>

**Figure 3-37b:** Distance Remoted ($d_R$) And Elevation ($e$). Para 323.c.
EXAMPLE – ELEVATION DIFFERENCE

AIRPORT – E = 2800’ – 800’ = 2000’ x .14 = 280’
HELIPORT/VERTIPOORT – E = 5800’ – 800’ = 5000’ x .14 = 700’

Figure 3-37c: Elevation Differential Area (EDA) Where Intervening Terrain Influences Atmospheric Pressure Patterns. Para 323.c.
SECTION 3. VISIBILITIES

330. Establishment Of Visibility Minima

a. NON-PRECISION Straight-in minima shall be established for an approach category when:

(1) The final approach course-runway alignment criteria have been met; AND

(2) The height of the DA or MDA above the touchdown zone (TDZ) and the associated visibility are within the tolerances specified in Para 331; AND

(3) The descent gradient from the final approach fix to the runway does not exceed the maximum specified in the applicable facility chapter of this document.

b. PRECISION Straight-in minima shall be established for an approach category when the final approach course alignment criteria have been met.

c. The minimum visibility prior to applying credit for lights shall not be less than;

(1) the visibility required in Para 331; or

(2) the MAP to threshold distance (where the MAP is reached before the threshold), whichever is greater.

d. When straight-in minima are not authorized, only circling MDAs and visibilities will be established. In establishing circling visibility minima, Para 331 applies. These minima shall be no lower than those specified in Para 351.

e. Circling minima shall NOT be lower than straight-in landing minima.

331. Effect Of HAA/HAT And Facility Distance On Straight-In And Circling Visibility Minima/Advisory Visibility

The minimum standard visibility required for the pilot to establish visual reference in time to descend safely from the DA or MDA is dependent upon the HAT/HAA. The minimum standard visibility is specified in Table 3–2.

332. Effect Of DA On Precision Visibility Minima/Advisory Visibility

The minimum standard visibility required for the pilot to establish reference in time to descend safely from the DA is dependent upon the HAT. The minimum standard visibility is specified in Table 3–3.

333. Runway Visual Range (RVR)

An RVR sensor system is used for measuring the visibility along the runway. It is an instrumentally derived value that represents the horizontal distance a pilot will see down the runway from the approach end. It is based on the sighting of either high intensity runway lights or the visual contrast of other targets; whichever yields the greater visual range.

334. Reserved
335. Comparable Values Of RVR And Ground Visibility

If RVR minima for take-off or landing are prescribed in an instrument approach procedure but RVR is not reported for the runway of intended operation, the RVR minima shall be converted to ground visibility in accordance with Table 3–4, and observed as the applicable visibility minimum for take-off or landing on that runway.

336—339. Reserved
SECTION 4. VISIBILITY CREDIT FOR LIGHTS

340—342. Reserved

343. Visibility Reduction

Standard visibility requirements are computed by applying the criteria contained in Para 331. These requirements may be reduced by giving credit for appropriate light systems as shown in Table 3–2.

Note: No credit is given for approach light systems for circling approaches.

344—349. Reserved

SECTION 5. STANDARD MINIMA

350. Standard Straight-In Minima

Table 3–1 specifies the lowest minima which may be prescribed for various combinations of electronic and visual navigation aids. Lower minima based on special equipment or aircrew qualifications may be authorized only by TC HQ or DND HQ, as applicable. Higher minima shall be specified where required by application of criteria contained elsewhere in this document.

351. Standard Circling Minima

Table 3–1 specifies the lowest minima which may be prescribed for circling approaches. See also Para 330.c. The MDA established by application of the minima specified in this paragraph shall be rounded to the next higher 20-foot increment.

352—359. Reserved

SECTION 6. ALTERNATE MINIMA

360. Alternate Weather Minima

Determining the weather requirements for an alternate is the responsibility of the pilot-in-command based upon criteria detailed in the Canada Air Pilot and A.I.P. Canada. For military procedures, see BGA-100-001/AA-000.

361—369. Reserved

SECTION 7. DEPARTURES

370. Take-Off Minima

All take-off minima shall be determined by applying Vol 1, Chap 12 of this document to all conventional departure procedures and Standard Instrument Departures (SIDs). The appropriate RNAV criteria shall be applied for all RNAV Departures and SIDs. Published minima are detailed in the Canada Air Pilot and appropriate Military publications.

371—399. Reserved
<table>
<thead>
<tr>
<th>TYPE OF APPROACH</th>
<th>MINIMA</th>
<th>HEIGHT</th>
<th>VISIBILITY (SM)</th>
<th>RVR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILS CAT III</td>
<td>NA</td>
<td>NA</td>
<td>06</td>
<td></td>
</tr>
<tr>
<td>ILS CAT II</td>
<td>HAT 100 FT</td>
<td>NA</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>PAR, ILS CAT I</td>
<td>HAT 200 FT</td>
<td>1/2</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>HIAL INOP</td>
<td>HAT 250 FT</td>
<td>1</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>RNP-AR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNAV (LPV, LP, LNAV/VNAV, LNAV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOC, LOC BACK COURSE</td>
<td>HAT 250 FT</td>
<td>1</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>VOR/DME, TACAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOR WITH FAF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOR WITHOUT FAF</td>
<td>HAT 300 FT</td>
<td>1</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>NDB WITH FAF</td>
<td>HAT 300 FT</td>
<td>1</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>NDB WITHOUT FAF</td>
<td>HAT 350 FT</td>
<td>1</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>CIRCLING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAT A and B</td>
<td>HAA 500 FT</td>
<td>1 1/2</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>CAT C</td>
<td>HAA 500 FT</td>
<td>2</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>CAT D and E</td>
<td>HAA 600 FT</td>
<td>2</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** All calculated minima values shall be rounded to whole number increments as follows:
- DA – next higher 1’ increment (i.e., 196.2’ = 197’)
- TCH – next lower 1’ increment (i.e., 46.75’ = 46’)
- MDAs – next higher 20-foot increment (i.e., 414’ = 420’)
- Sector Altitudes – next higher 100-foot increments (i.e., 2036’ = 2100’)
- HAT – next higher 1-foot increment (i.e., 257.2’ = 258’)
- HAA – next higher 1-foot increment (i.e., 414.4’ = 415’)

**Table 3-1: Standard Straight-In And Circling Minima. Para 350 and 351.**
<table>
<thead>
<tr>
<th>HAT/HAA RANGE</th>
<th>VISIBILITY (SM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250’ – 347’</td>
<td>1</td>
</tr>
<tr>
<td>348’ – 434’</td>
<td>1 ¼</td>
</tr>
<tr>
<td>435’ – 521’</td>
<td>1 ½</td>
</tr>
<tr>
<td>522’ – 608’</td>
<td>1 ¾</td>
</tr>
<tr>
<td>609’ – 695’</td>
<td>2</td>
</tr>
<tr>
<td>696’ – 782’</td>
<td>2 ¼</td>
</tr>
<tr>
<td>783’ – 869’</td>
<td>2 ½</td>
</tr>
<tr>
<td>870’ – 956’</td>
<td>2 ¾</td>
</tr>
<tr>
<td>957” and above</td>
<td>3</td>
</tr>
</tbody>
</table>

**Note:** If the landing runway is served by an operational high intensity (HIAL), MALSR (AM) or SSALR (AN) approach lighting system, the visibility may be reduced by ½ SM, but at no time to a value less than 1 SM or that shown in Table 3-1, whichever is higher. On circling approaches, no visibility credit will be given for approach lights.

Table 3-2: Non-Precision Minima Visibility Matrix. Para 331 and 343.

<table>
<thead>
<tr>
<th>HAT</th>
<th>VISIBILITY (SM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100’ – 199’</td>
<td>RVR down to 1200</td>
</tr>
<tr>
<td>200’ – 249’</td>
<td>½</td>
</tr>
<tr>
<td>≥ 250’</td>
<td>use Table 3-2</td>
</tr>
</tbody>
</table>

Table 3-3: Precision Minima Visibility Matrix. Para 332.

<table>
<thead>
<tr>
<th>RVR</th>
<th>VISIBILITY (SM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td>¼</td>
</tr>
<tr>
<td>2600</td>
<td>½</td>
</tr>
<tr>
<td>4000</td>
<td>¾</td>
</tr>
<tr>
<td>5000</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3-4: Comparable Values Of RVR And Ground Visibility. Para 335.
### Aircraft Category

<table>
<thead>
<tr>
<th>GPA</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D &amp; E</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50° - 2.99° (DND only)</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.00° - 3.10°</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.11° - 3.30°</td>
<td>200</td>
<td>250</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>3.31° - 3.60°</td>
<td>200</td>
<td>270</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>3.61° - 3.80°</td>
<td>200</td>
<td></td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>3.81° - 4.20°</td>
<td>200</td>
<td>250</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>4.21° - 5.00°</td>
<td>250</td>
<td></td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>5.01° - 5.70°</td>
<td>300</td>
<td></td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>5.71° - 6.40° Airspeed NTE 80 knots</td>
<td>350</td>
<td></td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** LPV GPA > 3.5° = 250 minimum

| Table 3-5. Minimum HAT for PA and APV Approach Procedures as a function of GPA. Para 323.a. |
CHAPTER 4. ON-AIRPORT VOR (NO FAF)

400. General

This chapter is divided into two sections; one for low altitude procedures and one for high altitude teardrop penetration procedures. These criteria apply to procedures based on a VOR facility located on an airport in which no final approach fix (FAF) is established. These procedures must incorporate a procedure or a penetration turn. An ON-AIRPORT facility is one that is located:

a. For Straight-in Approach. Within one mile of the nearest portion of the landing runway.

b. For Circling Approach. Within one mile of the nearest portion of the usable landing surface of the airport.

401—409. Reserved

SECTION 1. LOW ALTITUDE PROCEDURES

410. Feeder Routes

Criteria for feeder routes are contained in Para 220.

411. Initial Approach Segment

The initial approach fix is received by overheading the navigation facility. The initial approach is a procedure turn. The criteria for the procedure turn areas are contained in Para 234.

412. Intermediate Approach Segment

This type of procedure has no intermediate segment. Upon completion of the procedure turn, the aircraft is on final approach.

413. Final Approach Segment

The final approach begins where the procedure turn intersects the final approach course inbound.

a. Alignment. The alignment of the final approach course with the runway centreline determines whether a straight-in or circling approach may be established.

(1) Straight-in. The angle of convergence of the final approach course and the extended runway centreline shall not exceed 30 degrees. The final approach course should be aligned to intersect the extended runway centreline 3,000 feet outward from the runway threshold. When an operational advantage can be achieved this point of intersection may be established at any point between the runway threshold and a point 5,200 feet outward from the runway threshold. Also, where an operational advantage can be achieved, a final approach course which does not intersect the runway centreline, or intersects it at a distance greater than 5,200 feet from the threshold, may be established provided such a course lies within 500 feet laterally of the extended runway centreline at a point 3,000 feet outward from the runway threshold. Straight-in category C, D, and E minimums are not authorized when the final approach course intersects the extended runway centreline at an angle greater than 15° and a distance less than 3,000 feet (see Figure 4-38).

(2) Circling Approach. When the final approach course alignment does not meet the criteria for straight-in landing, only a circling approach shall be authorized, and the
course alignment should be made to the centre of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to pass through any portion of the usable landing surface. See Figure 4-39.

b. Area. Figure 4-40 illustrates the final approach primary and secondary areas. The primary area is longitudinally centred on the final approach course, and is 10 miles long. The primary area is 2 miles wide at the facility and expands uniformly to 6 miles at 10 mile from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility and expands uniformly to 1.34 miles on each side of the primary area at 10 miles from the facility. When the 5 mile procedure turn is used, only the inner 5 miles of the final approach area need be considered.

c. Obstacle Clearance.

(1) **Straight-in.** The minimum obstacle clearance in the primary area is 300 feet. In the secondary area, 300 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge.

(2) **Circling Approach.** In addition to the minimum requirements specified in Para 413.c.(1), obstacle clearance in the circling area shall be as prescribed in Chapter 2, Section 6.

d. **Procedure Turn Altitude** (Descent Gradient). The procedure turn completion altitude shall be within 1,500 feet of the MDA (1,000 feet with a 5-mile procedure turn), provided the distance from the facility to the point where the final approach course intersects the runway centreline (or the first usable portion of the landing area for "circling only" procedures) does not exceed 2 miles. When this distance exceeds 2 miles, the maximum difference between the procedure turn completion altitude and the MDA shall be reduced at the rate of 25 feet for each one tenth of a mile in excess of 2 miles. See Figure 4-41.

**Note:** For those procedures in which the final approach does NOT intersect the extended runway centreline within 5,200 feet of the runway threshold (see Para 413.a.(1)) the assumed point of intersection for computing the distance from the facility shall be 3,000 feet from the runway threshold. See Figure 4-38.

e. **Use of Step-down Fix.** Use of the step-down fix (Para 288.c) is permitted provided the distance from the facility to the step-down fix does not exceed 4 miles. The descent gradient between PT completion altitude and stepdown altitude shall not exceed 150 ft/NM. The descent gradient will be computed based upon the difference in PT completion altitude minus stepdown fix altitude, divided by the specified PT distance, minus the facility to stepdown fix distance. Obstacle clearance may be reduced to 250 feet from the stepdown fix to the MAP/FEP. See Figure 4-42, Para 252.

f. **Minimum Descent Altitude.** Criteria for determining the MDA are contained in Chapter 3.
Note: Straight-in category C, D, and E minimums are not authorized when the final approach course intersects the extended runway centerline at an angle greater than 15° and a distance less than 3,000 feet.

Figure 4-38: Alignment Options For Final Approach Course. On-Airport VOR, No FAF, Straight-In Approach Procedure. Para 413.a.(1).

Figure 4-39: Alignment Options For Final Approach Course. On Airport VOR, No FAF, Circling Approach Procedure. Para 413.a.(2).
Figure 4-40: Final Approach Primary And Secondary Areas. On-Airport VOR, No FAF. Para 413.b.

Figure 4-41: Procedure Turn Altitude. On-Airport VOR, No FAF. Para 413.d.
414. Missed Approach Segment

Criteria for the missed approach segment are contained in Chapter 2, Section 7. The missed approach point is the facility. See Figure 4-42. The missed approach surface shall commence over the facility at the required height. See Para 274.

415—419. Reserved
SECTION 2. HIGH ALTITUDE TEARDROP PENETRATIONS

420. Feeder Routes
Criteria for feeder routes are contained in Para 220.

421. Initial Approach Segment
The initial approach fix is received by overheading the navigation facility. The initial approach is a teardrop penetration turn. The criteria for the penetration turn are contained in Para 235.

422. Intermediate Approach Segment
This procedure has no intermediate segment. Upon completion of the penetration turn, the aircraft is on final approach.

423. Final Approach Segment
An aircraft is considered to be on final approach upon completion of the penetration turn. However, the final approach segment begins on the final approach course 10 miles from the facility. That portion of the penetration procedure prior to the 10-mile point is treated as the initial approach segment. See Figure 4-6.

a. Alignment. Same as low altitude (Para 413.a).

b. Area. Figure 4-6 illustrates the final approach primary and secondary areas. The primary area is longitudinally centred on the final approach course, and is 10 miles long. The primary area is 2 miles wide at the facility, and expands uniformly to 8 miles at a point 10 miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility, and expands uniformly to 2 miles each side of the primary area at a point 10 miles from the facility.

c. Obstacle Clearance.

(1) Straight-in. The minimum obstacle clearance in the primary area is 500 feet. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge.

(2) Circling Approach. In addition to the minimum requirements specified in Para 423.c.(1), obstacle clearance in the circling area shall be as prescribed in Chapter 2, Section 6.

d. Penetration Turn Altitude (Descent Gradient). The penetration turn completion altitude shall be at least 1,000 feet, but not more than 4,000 feet, above the MDA on final approach.

e. Use of Step-down Fix. The use of the step-down fix is permitted provided the distance from the facility to the step-down fix does not exceed 10 miles. See Para 288.c.

f. Minimum Descent Altitude. In addition to the normal obstacle clearance requirement of the final approach segment (see Para 423.c), the MDA specified shall provide at least 500 feet of clearance over obstacles in the portion of the initial approach segment between the final approach segment and the point where the assumed penetration turn track intercepts the inbound course. See Figure 4-43.
424. Missed Approach Segment

Criteria for the missed approach segment are contained in Chapter 2, Section 7. The missed approach point is the facility. See Figure 4-43. The missed approach surface shall commence over the facility at the required height. See Para 274.

425—499. Reserved
CHAPTER 5. TACAN, VOR/DME AND VOR WITH FAF

500. General
This chapter applies to approach procedures based on VOR, VOR/DME, VORTAC or TACAN facilities in which a final approach fix (FAF) is established. The chapter is divided into two sections; Section 1 for VOR procedures that do not use DME as the primary method for establishing fixes, and Section 2 for VOR/DME and TACAN procedures, which use collocated, frequency, paired DME as the sole method of establishing fixes. When both the VOR and TACAN azimuth elements of a VORTAC station will support it, a single procedure, identified as a VOR/DME or TACAN shall be published. Such a procedure may be flown using either a VOR/DME or TACAN airborne receiver and shall satisfy TACAN terminal area fix requirements. See Para 286.c.

501—509. Reserved

SECTION 1. VOR WITH FAF

510. Feeder Routes
Criteria for feeder routes are contained in Para 220.

511. Initial Approach Segment
Criteria for the initial approach segment are contained in Chapter 2, Section 3. (see Figures 5-44a, 5-44b and 5-45.)

512. Intermediate Approach Segment
Criteria for the intermediate approach segment are contained in Chapter 2, Section 4. (see Figures 5–44a, 5-44b and 5–45.)

513. Final Approach Segment
The final approach may be made either FROM or TOWARD the facility. The final approach segment begins at the final approach fix and ends at the runway or missed approach point, whichever is encountered last.

   a. Alignment. The alignment of the final approach course with the runway centreline determines whether a straight-in or circling-only approach may be established. The alignment criteria differ depending on whether the facility is OFF or ON the airport. See definitions in Para 400.

      (1) Off-airport Facility.

         (a) Straight-in. The angle of convergence of the final approach course and the extended runway centreline shall not exceed 30 degrees. The final approach course should be aligned to intersect the runway centreline at the runway threshold. However, when an operational advantage can be achieved, the point of intersection may be established to as much as 3,000 feet outward along extended RWY centerline from the runway threshold. (see Figure 5–46.)

         (b) Circling Approach. When the final approach course alignment does not meet the criteria for a straight-in landing, only a circling approach shall be authorized, and the course alignment should be made to the centre of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to any portion of the usable landing surface. (see Figure 5–47.)
(2) On-airport Facility.

(a) **Straight-in.** The angle of convergence of the final approach course and the extended runway centreline shall not exceed 30 degrees. The final approach course should be aligned to intersect the extended runway centreline 3,000 feet outward from the runway threshold. When an operational advantage can be achieved, this point of intersection may be established at any point between the threshold and a point 5,200 feet outward from the threshold. Also, where an operational advantage can be achieved a final approach course which does not intersect the runway centreline, or which intersects it at a distance greater than 5,200 feet from the threshold, may be established, provided that such a course lies within 500 feet laterally of the extended runway centreline at a point 3,000 feet outward from the runway threshold. (see Figure 5–48.)

(b) **Circling Approach.** When the final approach course alignment does not meet the criteria for a straight-in landing, only a circling approach shall be authorized, and the course alignment should be made to the centre of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to any portion of the usable landing surface. (see Figure 5–49.)

b. **Area.** The area considered for obstacle clearance in the final approach segment starts at the final approach fix and ends at the runway or missed approach point, whichever is encountered last. It is a portion of a 30 nautical mile long trapezoid (see Figure 5–50), which is made up of primary and secondary areas. The primary area is centred longitudinally on the final approach course. It is 2 nautical miles wide at the facility, and expands uniformly to 5 nautical miles wide at 30 nautical miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility and expands uniformly to 1 nautical mile on each side of the primary area at 30 nautical miles from the facility. Final approaches may be made to airports, which are a maximum of 30 nautical miles from the facility. (see Figure 5–51.) The OPTIMUM length of the final approach segment is 5 nautical miles. The MAXIMUM length is 10 nautical miles. The MINIMUM length of the final approach segment shall provide adequate distance for an aircraft to make the required descent, and to regain course alignment when a turn is required over the facility. Table 5–14 shall be used to determine the minimum length needed to regain the course.

c. **Obstacle Clearance.**

   (1) **Straight-in Landing.** The minimum obstacle clearance in the primary area is 250 feet. In the secondary area 250 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge (see Figure 5-51a). Allowance for adjustments should be considered as specified in Para 323.

   (2) **Circling Approach.** In addition to the minimum requirements specified in Para 513.c.(1) above, obstacle clearance in the circling area shall be as prescribed in Chapter 2, Section 6.

d. **Descent Gradient.** Para 252 applies.

e. **Use of Fixes.** Criteria for the use of radio fixes are contained in Chapter 2, Section 8. Where a procedure is based on a procedure turn and an on-airport facility is the procedure turn fix, the distance from the facility to the FAF shall not exceed 4 miles.

f. **Minimum Descent Altitudes.** Criteria for determining the MDA are contained in Chapter 3, Section 2.
514. Missed Approach Segment
Criteria for the missed approach segment are contained in Chapter 2, Section 7. For VOR procedures, the missed approach point and surface shall be established as follows:

a. Off-airport Facilities.
   (1) **Straight-in.** The missed approach point is a point on the final approach course, which is not farther from the final approach fix than the runway threshold. (see Figure 5-52.) The missed approach surface shall commence over the missed approach point at the required height. (See Para 274.)

   (2) **Circling Approach.** The missed approach point is a point on the final approach course, which is not farther from the final approach fix than the first usable portion of the landing area. The missed approach surface shall commence over the missed approach point at the required height. (See Para 274.)

b. On-airport Facilities. The missed approach point is a point on the final approach course, which is not farther from the final approach fix than the facility. The missed approach surface shall commence over the missed approach point at the required height. (See Para 274.)

515—519. Reserved

**SECTION 2. TACAN AND VOR/DME**

520. Feeder Routes
Criteria for feeder routes are contained in Para 220.

521. Initial Approach Segment
Due to the fixing capability of TACAN and VOR/DME a procedure turn initial approach may not be required. Criteria for initial approach segments are contained in Chapter 2, Section 3.

522. Intermediate Approach Segment
Criteria for the intermediate segment are contained in Chapter 2, Section 4.

523. Final Approach Segment
TACAN and VOR/DME final approaches may be based either on arcs or radials. The final approach begins at a final approach fix and ends at the missed approach point. The missed approach point is always marked with a fix.

a. **Radial Final Approach.** Criteria for the radial final approach are specified in Para 513.

b. **Arc Final Approach.** The final approach arc shall be a continuation of the intermediate arc. It shall be specified in nautical miles and tenths thereof. Arcs closer than 7 miles (15 miles for high altitude procedures) and farther than 30 miles from the facility shall not be used for final approach. No turns are permitted over the final approach fix.

   (1) **Alignment.** For Straight-in approaches, the final approach arc shall pass through the runway threshold when the angle of convergence of the runway centreline and the tangent of the arc does not exceed 15 degrees. When the angle exceeds 15 degrees the final approach arc shall be aligned to pass through the centre of the airport and only circling minimums shall be authorized. (see Figure 5–53.)
(2) **Area.** The area considered for obstacle clearance in the arc final approach segments starts at the final approach fix and ends at the runway or missed approach point, whichever is encountered last. It should not be more than 5 miles long. It shall be divided into primary and secondary areas. The primary area is 8 miles wide, and extends 4 miles on either side of the arc. A secondary area is on each side of the primary area. The secondary areas are 2 miles wide on each side of the primary area. (see Figure 5-54.)

(3) **Obstacle Clearance.** The minimum obstacle clearance in the primary area is 500 feet. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge (see Figure 5-54a). Allowance for adjustments should be considered as specified in Para 323.

(4) **Descent Gradient.** Criteria for descents are specified in Para 252.

(5) **Use of Fixes.** Fixes along an arc are restricted to those formed by radials from the VORTAC facility which provides the DME signal. Criteria for such fixes are contained in Chapter 2, Section 8.

(6) **Minimum Descent Altitude.** Straight-in MDAs shall not be specified lower than circling for arc procedures. Criteria for determining the circling MDA are contained in Chapter 3, Section 2.

**524. Missed Approach Segment**

Criteria for the missed approach segment are contained in Chapter 2, Section 7. The missed approach point shall be a radial/DME fix. The missed approach surface shall commence over the fix and at the required height. (Also see Para 514.)

Note: The arc missed approach course may be a continuation of the final approach arc.

**525—599. Reserved**
Figure 5-44a: Typical Low Alt Approach Segments. VOR with FAF. Para 511 & 512.
Figure 5-44b: Typical Low Alt Approach Segments. VOR with FAF. Para 511 & 512.
Figure 5-45: Typical High Altitude Segments. VOR with FAF. Para 511 & 512.

Figure 5-46: Alignment Options For Final Approach Course. Off-airport VOR with FAF. Straight-in approach. Off-airport Para 513.1.(1)(a).
Tables 5–1 TO 5–13: Reserved

<table>
<thead>
<tr>
<th>Approach Category</th>
<th>Magnitude of Turn over the Facility (Degrees)</th>
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</thead>
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<tr>
<td></td>
<td>10°</td>
</tr>
<tr>
<td>A</td>
<td>1.0</td>
</tr>
<tr>
<td>B</td>
<td>1.5</td>
</tr>
<tr>
<td>C</td>
<td>2.0</td>
</tr>
<tr>
<td>D</td>
<td>2.5</td>
</tr>
<tr>
<td>E</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Note: This table may be interpolated. If turns of more than 30° are required, or if the minimum lengths specified in the table are not available, straight-in minima are not authorized. See Figure 5-51 for typical straight-in final approach areas.

Table 5-14: Minimum Length Of Final Approach Segment - VOR (NM). Para 513.b.
Figure 5-48: Alignment Options For Final Approach Course. On-Airport VOR, with FAF, Straight-In Approach Procedure. Para 513.a.(2)(a).
Figure 5-49: Alignment Options For Final Approach Course. On Airport VOR with FAF, Circling Approach Procedure. Para 513.a.(2)(b).

Figure 5-50: Final Approach Trapezoid. VOR with FAF. Para 513.b.
Figure 5-51: Typical Straight-In Final Approach. VOR with FAF. Para 513.b.
Secondary ROC = \( (250 + \text{adj}) \times \frac{(W_s - d)}{W_s} \)

Where:

- \( d \) = distance from inner edge to obstacle (ft)
- \( W_s \) = Width of secondary area (ft)
- \( \text{adj} \) = adjustments (ft) as per para 323.

**Figure 5-51a: Minimum Obstacle Clearance.** Para 513.c(1).

**Figure 5-52: Missed Approach Point.** Off-Airport VOR with FAF. Para 514.a.(1).
Figure 5-53: Arc Final Approach Alignment. Arc Aligned To Threshold. TACAN or VOR/DME. Para 523.b.(1).
Secondary ROC = \[(500 + \text{adj}) \times \frac{(W_S - d)}{W_S}\]

Where:
- \(d\) = distance from inner edge to obstacle (ft)
- \(W_S\) = Width of secondary area (ft)
- \(\text{adj}\) = adjustments (ft) as per para 323.

Figure 5-54a: Minimum Obstacle Clearance. Para 523.b(3).
CHAPTER 6. NDB PROCEDURES ON-AIRPORT FACILITY, NO FAF

600. General
This chapter is divided into two sections: one for low altitude procedures and one for high altitude teardrop penetration procedures. These criteria apply to NDB procedures based on a facility located on the airport in which no final approach fix is established. These procedures must incorporate a procedure turn or a penetration turn. An on-airport facility is one that is located:

a. For Straight-in Approach. Within 1 mile of any portion of the landing runway.

b. For Circling Approach. Within 1 mile of any portion of the usable landing surface on the airport.

601—609. Reserved
SECTION 1. LOW ALTITUDE PROCEDURES

610. Feeder Routes
Criteria for feeder routes are contained in Para 220.

611. Initial Approach Segment
The initial approach fix is received by overheading the navigation facility. The initial approach is a procedure turn. Criteria for the procedure turn areas are contained in Para 234.

612. Intermediate Approach Segment
This type of procedure has no intermediate segment. Upon completion of the procedure turn the aircraft is on final approach.

613. Final Approach Segment
The final approach begins where the procedure turn intersects the final approach course.

a. Alignment. The alignment of the final approach course with the runway centreline determines whether a straight-in or circling-only approach may be established.

(1) Straight-in. The angle of convergence of the final approach course and the extended runway centreline shall not exceed 30 degrees. The final approach course should be aligned to intersect the extended runway centreline 3,000 feet outward from the runway threshold. When an operational advantage can be achieved, this point of intersection may be established at any point between the runway threshold and a point 5,200 feet outward from the runway threshold. Also, where an operational advantage can be achieved a final approach course which does not intersect the runway centreline, or intersects it at a distance greater than 5,200 feet from the threshold, may be established provided that such course lies within 500 feet laterally of the extended runway centreline at a point 3,000 feet outward from the runway threshold. Straight-in category C, D, and E minimums are not authorized when the final approach course intersects the extended runway centerline at an angle greater than 15° and a distance less than 3,000 feet. (See Figure 6-55.)

(2) Circling Approach. When the final approach course alignment does not meet the criteria for straight-in landing, only a circling approach shall be authorized, and the course alignment should be made to the centre of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to pass through any portion of the usable landing surface. (See Figure 6-56.)

b. Area. Figure 6-57 illustrates the final approach primary and secondary areas. The primary area is longitudinally centred on the final approach course, and is 10 miles long. The primary area is 2.5 miles wide at the facility, and expands uniformly to 6 miles wide at 10 miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility, and expands uniformly to 1.34 miles on each side of the primary area at 10 miles from the facility. When the 5-mile procedure turn is used, only the inner 5 miles of the final approach area need be considered.
c. Obstacle Clearance.

(1) Straight-in. The minimum obstacle clearance in the primary area is 350 feet. In the secondary area, 350 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge. To determine ROC in the secondary area, see Figure 6-57a.

(2) Circling Approach. In addition to the minimum requirements specified in Para 613.c.(1), obstacle clearance in the circling area shall be as prescribed in Chapter 2, Section 6.

d. Procedure Turn Altitude (Descent Gradient). The procedure turn completion altitude shall be within 1,500 feet of the MDA (1,000 feet with a 5-mile procedure turn), provided the distance from the facility to the point where the final approach course intersects the runway centreline (or the first usable portion of the landing area for "circling only" procedures) does not exceed 2 miles. When this distance exceeds 2 miles, the maximum difference between the procedure turn completion altitude and the MDA shall be reduced at the rate of 25 feet for each one-tenth of a mile in excess of 2 miles. (see Figure 6-58.)

Note: For those procedures in which the final approach course does not intersect the extended runway centreline within 5,200 feet of the runway threshold (Para 613.a.(1)), the assumed point of intersection for computing distance from the facility shall be 3,000 feet from the runway threshold. (See Figure 6-55.)

e. Use of Step-down Fix. Use of the step-down fix (Para 288.c) is permitted provided the distance from the facility to the step-down fix does not exceed 4 miles. The descent gradient between PT completion altitude and stepdown fix altitude shall not exceed 150 ft/NM. The descent gradient will be computed based upon the difference in PT completion altitude minus stepdown fix altitude, divided by the specified PT distance, minus the facility to stepdown fix distance. Obstacle clearance may be reduced to 300 feet from the stepdown fix to the MAP/FEP (see Figure 6-59, and Paras 251, 252, and 253).

f. Minimum Descent Altitude. Criteria for determining the MDA are contained in Chapter 3, Section 2.

614. Missed Approach Segment

Criteria for the missed approach segment are contained in Chapter 2, Section 7. The missed approach point is the facility. (see Figure 6-59. The missed approach surface shall commence over the facility at the required height. (See Para 274.)

615—619. Reserved
SECTION 2. HIGH ALTITUDE TEARDROP PENETRATIONS

620. Feeder Routes
Criteria for feeder routes are contained in Para 220.

621. Initial Approach Segment
The initial approach fix is received by overheading the navigation facility. The initial approach is a teardrop penetration turn. The criteria for the penetration turn are contained in Para 235.

622. Intermediate Approach Segment
The procedure has no intermediate segment. Upon completion of the penetration turn, the aircraft is on final approach.

623. Final Approach Segment
An aircraft is considered to be on final approach upon completion of the penetration turn. However, the final approach segment begins on the final approach course 10 miles from the facility. That portion of the penetration procedure prior to the 10-mile point is treated as the initial approach segment. (see Figure 6-60.)

a. Alignment. Same as low altitude criteria. (See Para 613.a.)

b. Area. Figure 6-60 illustrates the final approach primary and secondary areas. The primary area is longitudinally centred on the final approach course, and is 10 miles long. The primary area is 2.5 miles wide at the facility, and expands uniformly to 8 miles at 10 miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility and expands uniformly to 2 miles each side of the primary area at 10 miles from the facility.

c. Obstacle Clearance.

   (1) Straight-in. The minimum obstacle clearance in the primary area is 500 feet. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge. The minimum required obstacle clearance at any given point in the secondary area is shown in Annex C, Figure C–3.

   (2) Circling Approach. In addition to the minimum requirements specified in Para 623.c.(1), obstacle clearance in the circling area shall be as prescribed in Chapter 2, Section 6.

d. Penetration Turn Altitude (Descent Gradient). The penetration turn completion altitude shall be at least 1,000 feet, but not more than 4,000 feet above the MDA on final approach.

e. Use of a Step-down Fix. Use of a step-down fix (see Para 288.c) is permitted, provided the distance from the facility to the step-down fix does not exceed 10 miles.

f. Minimum Descent Altitude. In addition to the normal obstacle clearance requirements of the final approach segment (see Para 623.c), the MDA specified shall provide at least 1000 feet of clearance over obstacles in that portion of the initial approach segment between the final approach segment and the point where the assumed penetration turn track intercepts the inbound course. (See Figure 6-60.)
624. Missed Approach Segment
Criteria for the missed approach segment are contained in Chapter 2, Section 7. The missed approach point is the facility. (See Figure 6-60.) The missed approach surface shall commence over the facility at the required height. (See Para 274.)

625—699. Reserved

Figure 6-1 TO 6-54: Reserved

Figure 6-55: Alignment Options For Final Approach Course. On-Airport NDB, No FAF, Straight-In Procedure. Para 613.a.(1).

*Supplementary Note:* In diagram (1), the “Maximum Angle At Any Point” for CAT A & B is 30 degrees, and for CAT C, D & E is 15 degrees (Para 613.a.)
Figure 6-56: Alignment Options For Final Approach Course. On Airport NDB, No FAF, Circling Approach. Para 613.a.(2)

Figure 6-57: Final Approach Primary And Secondary Areas. On-Airport NDB, No FAF. Para 613.b.
Secondary ROC = \((350 + adj) \times \frac{(W_S - d)}{W_S}\)

Where:
- \(d\) = distance from inner edge to obstacle (ft)
- \(W_S\) = Width of secondary area (ft)
- \(adj\) = adjustments (ft) as per para 323.

**Figure 6-57a: Secondary ROC. Para 6-13.c.**
When this distance exceeded, the difference between the procedure turn altitude and the MDA must be reduced by 25 feet for each additional tenth of a NM.

Figure 6-58: Procedure Turn Altitude. On-Airport NDB, No FAF. Para 613.d.
Figure 6-59: Use Of Step-Down Fix. On-Airport NDB, No FAF. Para 613.e.
Figure 6-60: Penetration Turn. On Airport VOR, No FAF. Para 623.
CHAPTER 7. NDB WITH FAF

700. General
This chapter prescribes criteria for NDB procedures that incorporate a final approach fix. NDB procedures shall be based only on facilities that transmit a continuous carrier.

701—709. Reserved

SECTION 1. NDB WITH FAF

710. Feeder Routes
Criteria for feeder routes are contained in Para 220.

711. Initial Approach Segment
Criteria for the initial approach are contained in Chapter 2, Section 3.

712. Intermediate Approach Segment
Criteria for the intermediate approach segment are contained in Chapter 2, Section 4.

713. Final Approach Segment
The final approach may be made either FROM or TOWARD the facility. The final approach segment begins at the final approach fix and ends at the runway or missed approach point, whichever is encountered last.

Note: Criteria for the establishment of arc final approaches are specified in Para 523.b.

a. The alignment of the final approach course with the runway centreline determines whether a straight-in or circling-only approach may be established. The alignment criteria differ depending on whether the facility is OFF or ON the airport. See definition in Para 400.

   (1) Off-airport Facility.

      (a) Straight-in. The angle of convergence of the final approach course and the extended runway centreline shall not exceed 30 degrees. The final approach course should be aligned to intersect the runway centreline at the runway threshold. However, when an operational advantage can be achieved, the point of intersection may be established anywhere from the runway threshold to as much as 3,000 feet outward from the runway threshold. (See Figure 7-61.)

      (b) Circling Approach. When the final approach course alignment does not meet the criteria for straight-in landing, only a circling approach shall be authorized, and the alignment should be made to the centre of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to any portion of the usable landing surface. (See Figure 7-62.)
(2) On-airport Facility.

   (a) **Straight-in.** The angle of convergence between the final approach course and the extended runway centreline shall not exceed 30 degrees. The final approach course should be aligned to intersect the extended runway centreline 3,000 feet outward from the runway threshold. When an operational advantage can be achieved, this point of intersection may be established at any point between the runway threshold and a point 5,200 feet outward from the runway threshold. Also, where an operational advantage can be achieved, a final approach course which does not intersect the runway centreline, or which intersects it at a distance greater than 5,200 feet from the threshold, may be established provided such a course lies within 500 feet laterally of the extended runway centreline at a point 3,000 feet outward from the runway threshold (See Figure 7-63).

   (b) **Circling Approach.** When the final approach course alignment does not meet the criteria for a straight-in landing, only a circling approach shall be authorized, and the course alignment should be made to the centre of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to any portion of the usable landing surface. (See Figure 7-64).

b. **Area.** The area considered for obstacle clearance in the final approach segment starts at the final approach fix and ends at the runway or missed approach point, whichever is encountered last. It is a portion of a 15 nautical mile long trapezoid (see Figure 7-65), which is made up of primary and secondary areas. The primary area is centred longitudinally on the final approach course. It is 2.5 nautical miles wide at the facility and expands uniformly to 5 nautical miles at 15 nautical miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility, and expands uniformly to 1 nautical mile each side of the primary area at 15 nautical miles from the facility. Final approaches may be made to airports which are a maximum of 15 nautical miles from the facility. The **OPTIMUM** length of the final approach segment is 5 nautical miles. The **MAXIMUM** length is 10 nautical miles. The **MINIMUM** length of the final approach segment shall provide adequate distance for an aircraft to make the required descent, and to regain course alignment when a turn is required over the facility. Table 7-15 shall be used to determine the minimum length needed to regain the course.

c. **Obstacle Clearance.**

   (1) **Straight-in.** The minimum obstacle clearance in the primary area is 300 feet. In the secondary area, 300 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge (see Figure 6-66a). Allowance for adjustments should be considered as specified in Para 323.

   (2) **Circling Approach.** In addition to the minimum requirements specified in Para 713.c.(1), obstacle clearance in the circling area shall be as prescribed in Chapter 2, Section 6.

d. **Descent Gradient.** Para 252 applies

e. **Use of Fixes.** Criteria for the use of radio fixes are contained in Chapter 2, Section 8. Where a procedure is based on a procedure turn and an on-airport facility is the procedure turn fix, the distance from the facility to the FAF shall not exceed 4 nautical miles.

f. **Minimum Descent Altitude.** Criteria for determining the MDA are contained in Chapter 3, Section 2.
714. Missed Approach Segment

Criteria for the missed approach segment are contained in Chapter 2, Section 7. The missed approach point and surface shall be established as follows:

a. Off-airport Facilities.

(1) **Straight-in.** The missed approach point is a point on the final approach course which is not farther from the FAF than the runway threshold. The missed approach surface shall commence over the missed approach point at the required height. (See Para 274 and Figure 7-67.)

(2) **Circling Approach.** The missed approach point is a point on the final approach course which is not farther from the final approach fix than the first usable portion of the landing area. The missed approach surface shall commence over the missed approach point at the required height. (See Para 274.)

b. On-airport Facilities. The missed approach point is a point on the final approach course which is not farther from the final approach fix than the facility. The missed approach surface shall commence over the missed approach point at the required height. (See Para 274.)

715—799. Reserved

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**Table 7-1 TO 7-14: Reserved**

<table>
<thead>
<tr>
<th>Approach Category</th>
<th>Magnitude of Turn over Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10°</td>
</tr>
<tr>
<td>A</td>
<td>1.0</td>
</tr>
<tr>
<td>B</td>
<td>1.5</td>
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<tr>
<td>C</td>
<td>2.0</td>
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<tr>
<td>D</td>
<td>2.5</td>
</tr>
<tr>
<td>E</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Note:** This table may be interpolated. If turns of more than 30° are required, or if the minimum lengths specified in the table are not available, straight-in minima are not authorized. See Figure 7-66 for typical final approach areas.
Figure 7-61: Alignment Options For Final Approach Course. Off-Airport NDB with FAF. Straight-In Approach. Para 713.a.(1)(a).

Figure 7-62: Alignment Options For Final Approach Course. Off-Airport NDB with FAF. Circling Approach. Para 713.a.(1)(b).
Figure 7-63: Alignment Options For Final Approach Course. On-Airport NDB. Para 713.a.(2)(a).

Figure 7-64: Alignment Options For Final Approach Course. On Airport NDB with FAF, Circling Approach. Para 713.a.(2)(b).
Figure 7-65: Final Approach Trapezoid. NDB with FAF. Para 713.b.

Secondary ROC = \( (300 + \text{adj}) \times \frac{(W_s - d)}{W_S} \)

Where:
- \( d \) = distance from inner edge to obstacle (ft)
- \( W_s \) = Width of secondary area (ft)
- \( \text{adj} \) = adjustments (ft) as per para 323.

Figure 7-66a: Minimum Obstacle Clearance. Para 713.c.
Figure 7-66: Typical Final Approach Areas. NDB with FAF. Para 713.b.
Figure 7-67: Missed Approach Point. Off-Airport NDB with FAF. Para 714.a.(1).
CHAPTER 8. EMERGENCY VHF/UHF DF PROCEDURES

800. General

These criteria apply to Direction Finding (DF) procedures for both high and low altitude aircraft. DF criteria shall be the same as criteria provided for automatic direction finder (ADF) procedures, except as specified herein. As used in this chapter, the word “facility” means the DF antenna site. DF approach procedures are established for use in emergency situations. Detailed operational instructions for Emergency VHF/UHF DF Procedures are contained in Flight Service Station MANOPS 5-10 and 6-70.

801—809. Reserved

SECTION 1. VHF/UHF DF CRITERIA

810. En Route Operations

En route aircraft under DF control follow a course to the DF station as determined by the DF controller. A minimum safe altitude shall be established which provides at least 1,000 feet (1,500 or 2,000 feet in mountainous areas) of clearance over all obstacles within the operational radius of the DF facility. When this altitude proves unduly restrictive, sector altitudes may be established to provide relief from obstacles that are clear of the area where flight is conducted. Where sector altitudes are established, they shall be limited to sectors of not less than 45 degrees in areas BEYOND a 10-mile radius around the facility. For areas WITHIN 10 miles of the facility, sectors of NOT LESS THAN 90 degrees shall be used. Because the flight course may coincide with the sector division line, the sector altitude shall provide at least 1,000 feet (2,000 feet in mountainous terrain) of clearance over obstacles in the adjacent sectors within 6 miles or 20 degrees of the sector division line, whichever is the greater. No sector altitude shall be specified which is lower than the procedure turn altitude or lower than the altitude for area sectors which are closer to the navigation facility.
811. **Initial Approach Segment**

The initial approach fix is overhead the facility.

a. **Area.** The initial approach is a low altitude triangular procedure illustrated in Figure 8-1. When the triangular procedure is used, final descent is based on a single heading at 500 feet per minute rate of descent. (See Table 8-1 and Figure 8-2.)

<table>
<thead>
<tr>
<th>Aircraft Ground Speed (Knots)</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>110</th>
<th>120</th>
<th>Time (Mins)</th>
<th>Descent in feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descent (feet per NM)</td>
<td>500</td>
<td>429</td>
<td>375</td>
<td>330</td>
<td>300</td>
<td>272</td>
<td>250</td>
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<tr>
<td>Distance (NM) covered for time flown at estimated compared to descent in feet (Last two columns)</td>
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<td>Note: Distances are to nearest tenth of a nautical mile (NM)</td>
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<th>Aircraft Ground Speed (Knots)</th>
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<th>90</th>
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</tr>
<tr>
<td>Distance (NM) covered for time flown at estimated compared to descent in feet (Last two columns)</td>
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<td>Note: Distances are to nearest tenth of a nautical mile (NM)</td>
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</table>

**Table 8-1: DF Emergency Descent Gradients. Para 811.a.**

b. **Obstacle Clearance.** Obstacle clearance in the initial approach primary area shall be a MINIMUM of 1,000 feet. Obstacle clearance at the inner edge of the secondary area shall be 500 feet, tapering to zero feet at the outer edge. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet provided the ROC is not violated. (See Para 231.)

812. **Intermediate Approach Segment**

Except as outlined in this paragraph, criteria for the intermediate segment are contained in chapter 2, section 4. An intermediate segment is used only when the DF facility is located off the airport, and the final approach is made from overhead the facility to the airport or visual contact area.

a. **Area.** The width of the primary intermediate area is 3.4 nautical miles at the facility expanding uniformly on each side of the course to 8 nautical miles wide 10 nautical miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility expanding along the primary area to 2 nautical miles each side at 10 nautical miles from the facility. (See Figure 8-3.)
b. Obstacle Clearance. A MINIMUM of 500 feet of obstacle clearance shall be provided in the primary area of the intermediate approach segment. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge. The minimum obstacle clearance required at any given point in the secondary area may be determined by using formula specified in Para 523.b. The altitudes selected by application of the obstacle clearance specified in this paragraph shall be rounded to the nearest 100 feet, provided the ROC is not violated. (See Para 241.)

The obstacle clearance is applied to provide clearance until the inbound aircraft is over the facility. Descent through cloud is commenced at a point as determined by the DF controller, using the DF Emergency Descent Gradients (see Table 8-1). The objective is to have the aircraft descend at a constant rate so as to pass over the facility with at least 500 feet obstacle clearance.

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**Figure 8-1: Triangular Turn Area. Para 811.a.**
Figure 8-2: DF Descent Distance/ Airspeed Profiles. Para 811.a.

Figure 8-3: Off-Airport DF Intermediate Approach Area On-Airport DF Final Approach Area. Para 812 and 813.
813. Final Approach Segment

The final approach begins at the facility for off-airport facilities or where the procedure turn intersects the final approach course for on-airport facilities (see Para 400 for the definition of on-airport facilities). DF procedures shall not be developed for airports that are more than 10 nautical miles from the DF facility. When a facility is located in excess of 6 nautical miles from an airport, the instrument approach shall end at the facility and flight to the airport shall be conducted in accordance with Visual Flight Rules (VFR).

a. Alignment. Final approach course alignment with the runway is not a consideration in Emergency VHF/UHF DF Procedures.

b. Area.

(1) On-airport Facilities. Figure 8-3 illustrates the final approach primary and secondary areas. The primary area is longitudinally centred on the final approach course and is 10 nautical miles long. The primary area is 3.4 nautical miles wide at the facility and expands uniformly to 8 nautical miles wide at 10 nautical miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility and expands uniformly to 2 nautical miles on each side of the primary area at 10 nautical miles from the facility.

(2) Off-airport Facilities. The area considered is identical to that described in Para 713a(1)(a) and (b) and Figure 7-65 except that the primary area is 3.4 nautical miles wide at the facility.

(3) Final Approach to Visual Contact Area. (DF site located on or off-aerodrome). Figure 8-4 illustrates the final approach area. The segment starts at the VHF/DF site and ends at the visual contact area that is a portion of a 15 nautical mile long trapezoid located in the best area for emergency descent. The area is centred longitudinally on the final descent course. It is 3.4 nautical miles wide at the facility and expands uniformly to 8 nautical miles at 15 nautical miles from the facility. Final approach should be made within a maximum of 15 nautical miles from the facility. The MINIMUM length of the final approach segment shall provide adequate distance for an aircraft to make a descent at 500 feet per nautical mile from the minimum altitude (1,000 feet obstacle clearance) over the VHF/DF facility down to 500 feet above the highest centreline elevation of obstacles in the visual contact area. For the MAXIMUM length, descent at 250 feet per mile shall be used. These calculations form the beginning and end of the visual contact area and the width is formed by the boundaries of the trapezoid. (See Table 8-1). The profile in Figure 8-4 illustrates a descent of 3,500 feet, ceiling of 500 feet, rate of descent 500 feet per minute and the visual contact area for ground speeds from 60 to 120 knots.

c. Obstacle Clearance.

(1) Straight-in. The minimum obstacle clearance in the primary area is 500 feet. In the secondary areas, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge. The minimum required obstacle clearance at any given point in the secondary area can be computed by using the formula specified in para 523.b.

(2) Final Approach to Visual Contact Area. The minimum obstacle clearance in the final approach segment to the visual contact area is 500 feet. An inclined plane is used within the final approach area, originating at the facility with at least 1,000 feet of obstacle clearance and descending at 500 feet per nautical mile to 500 feet above
the highest obstacle in the centreline zone of the visual contact area. The centreline zone boundaries shall be 3,000 feet either side of centreline. The minimum obstacle clearance of 500 feet is maintained between the inclined plane and obstacles in the descending portion of the final approach area. If 500 feet of obstacle clearance from the inclined plane cannot be maintained, the point of origin over the facility is raised accordingly. Example: if the inclined plane originating at the facility with 1,000 feet of obstacle clearance clears the governing obstacle by only 400 feet then the point of origin is raised by 100 feet. (See Figure 8-4.)

**814. Missed Approach Segment**

Criteria for missed approach is not required for Emergency VHF/UHF/DF Cloud Breaking procedures.

**815—819. Reserved**
Figure 8-4: Final Approach Segment To Visual Contact Area. Para 813.b.(3) and Para c.(2).
SECTION 2. COMMUNICATIONS

820. Transmission Interval

DF navigation is based on voice transmission of heading and altitude instructions by a ground station to the aircraft. The MAXIMUM interval between transmissions is:

a. **En route Operations.** 60 seconds.

b. **From the Initial Approach Fix to Within an Estimated 30 Seconds of commencement of descent through cloud.** 15 seconds.

821—829. Reserved

SECTION 3. MINIMA

830. Approach Minima

No minimum descent altitude (MDA) is given. Prior to final descent the pilot will be informed of the aerodrome elevation. When the outbound type Emergency Cloud-Breaking procedure is used, the pilot will also be informed of the highest elevation of obstacles in the centreline zone of the visual contact area. (See Para 813.c.(2).) The objective is to have the aircraft descend at a constant rate, so as to pass over obstacles in the final approach segment with the required obstacle clearance, until 500 feet above aerodrome elevation is reached. The descent is continued until the aircraft is below cloud.

**Note:** See the Flight Service Station MANOPS 5-10 and 6-70 for procedure guidelines.

831—899. Reserved
CHAPTER 9. LOCALIZER


These criteria are contained in chapter 2, Sections 2, 3 and 4. When associated with a precision approach procedure, Volume 3, Para 2.3 applies.

901. Use of Localizer Only.

Where no usable glide slope is available, a localizer-only (front or back course) approach may be approved, provided the approach is made on a localizer from a final approach fix located within 10 nautical miles of the runway threshold. Back course procedures shall not be based on courses that exceed 6 degrees in width and shall not be approved for offset localizers. Back course procedures must be aligned within 3 degrees of the runway alignment.

902. Alignment.

Localizers are normally aligned within 3 degrees of the runway alignment. If the alignment exceeds 3 degrees the alignment shall meet the final approach alignment criteria for VOR on-airport facilities. See Chapter 5, Para 513, and Figure 5–48. Procedures developed utilizing localizers that are offset from the runway centreline up to and including 3° shall have an operational note published identifying the number of degrees of offset. Procedures developed utilizing localizers that are offset more than 3° shall have an operational note published indicating that the procedure is not aligned with the runway.

903. Area.

The final approach dimensions are specified in figure 9-75. However, only that portion of the final approach area that is between the FAF and the runway need be considered as the final approach segment for obstacle clearance purposes. The optimum length of the final approach segment is 5 nautical miles. The MINIMUM length of the final approach segment shall be sufficient to provide adequate distance for an aircraft to make the required descent. The area shall be centered on the FAC and shall commence at the runway threshold. For offset procedures, the final approach area shall commence at the facility and extend to the FAF. The MAP shall not be farther from the FAF than a point adjacent to the landing threshold perpendicular to the FAC. Calculate the width of the area using Vol 3, Chap 3 criteria.

904. Obstacle Clearance.

The minimum ROC in the final approach area is 250 feet in the W and X OCS. In addition, the MDA established for the final approach area shall assure that no obstacles penetrate the 7:1 transitional surfaces (Y OCS).

905. Descent Gradient.

The OPTIMUM gradient in the final approach segment is 318 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient for a straight-in is 400 feet per mile. When maximum straight-in descent gradient is exceeded, then a "circling only" procedure is authorized. When a stepdown fix is incorporated, descent gradient criteria must be met from FAF to SDF and SDF to FEP. See Para 251, 252, and 288a.
906. MDA.
The lowest altitude on final approach is specified as an MDA. The MDA adjustments specified in para 323 shall be considered.

907. Missed Approach Segment.
The criteria for the missed approach segment are contained in chapter 2, section 7. The MAP is on the FAC not farther from the FAF than the runway threshold (first usable portion of the landing area for circling approach). The missed approach surface shall commence over the MAP at the required height (see para 274).

908—999. Reserved
CHAPTER 10. RADAR APPROACH PROCEDURES AND VECTORING CHARTS

SECTION 1. GENERAL INFORMATION

10.0. GENERAL

This chapter applies to radar approach procedures utilizing ground-based radar.

10.0.1 Precision Approach Radar (PAR)

Precision Approach Radar is a system that graphically displays lateral course, glidepath, and distance from touchdown information of sufficient accuracy, continuity, and integrity to provide precision approach capability to a runway/landing area.

10.0.2 Surveillance Radar

Surveillance Radar is a system that displays direction and distance information with suitable accuracy, continuity, and integrity to safely provide radar vectoring capability for departures, arrivals, and en route operations.

10.0.3 Inoperative Components

Failure of azimuth and range information renders the entire PAR inoperative. When the glide slope feature becomes inoperative, the PAR reverts to a non-precision approach system. In such a case, obstacle clearance shall be as specified in Vol. 1, Chapter 9 for localizer approaches.

10.0.4 Lost Communications Procedures

The PAR procedure shall include instructions for the pilot to follow in the event of a loss of communications with the radar controller.

10.0.5 Minimum Vectoring Altitude Charts

See Annex B. Whenever it is necessary to deviate from established radar patterns, obstacle clearance prescribed in paragraph 10.1.1.a for diverse vectors shall be provided by approved minimum vectoring altitude charts (MVAC's) which depict all controlling obstacle(s) within the maximum range capability of the primary radar system. The chart is based upon the minimum clearance criteria and the maximum radar system range capability. Minimum vectoring altitude charts do not require flight inspection certification.
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SECTION 2. RADAR APPROACHES

10.1 RADAR APPROACHES

PAR procedures may be established where coverage and alignment tolerances are met.

10.1.1 Feeder Routes and Initial Approach Segments

Feeder and initial segments do not need to be established when navigation guidance and obstacle clearance are provided by Air Traffic Control radar vectors, during the transition from the enroute to the terminal phase of flight.

a. Feeder/Initial Segments based on Routes. When operationally required, establish feeder routes and/or initial segments based on conventional navigation, Area Navigation (RNAV), or radar routes.

(1) Conventional/RNAV Feeder/Initial. Develop in accordance with TP308/GPH209 Volume 1, chapter 2, section 2 and 3 or Volume 6 DOC 7 when Area Navigation (RNAV) is used.

(2) Radar Feeder/Initial. The route/segment begins at an established fix that permits positive radar identification and ends at the appropriate termination fix for the segment. Display the course centerline on a radar video map display.

(a) Alignment. Design feeder/initial and initial/initial segment intersections with the smallest amount of course change necessary for the procedure. The maximum allowable course change between segments is 90 degrees.

(b) Area. The Obstacle Evaluation Area (OEA) begins at the applicable radar fix displacement prior to the route/segment start fix and extends to the segment termination fix. Primary area half-width is equal to the minimum lateral clearance applicable to the radar adaptation (e.g. 3 NM if the aircraft is less than 40 NM from the antenna). There is no secondary area. The primary area has no specified maximum or minimum length; however, the segment must be long enough to permit the required altitude loss without exceeding the maximum authorized descent gradient.

Note: When the minimum lateral clearance changes within a segment (e.g. 5 NM to 3 NM), the OEA half-width also changes without the need to “splay” or “taper”.
(c) **Obstacle Clearance.** Apply the Volume 1, chapter 2 standard applicable to the segment. Volume 1, chapter 3 precipitous terrain adjustments apply.

(d) **Descent Angle.** Apply Volume 1, chapter 2 standard applicable to the segment.

(e) **Altitude Selection.** Apply Volume 1, chapter 2 standard applicable to the segment. Do not publish fix altitudes higher than the minimum required for obstacle clearance or airspace to achieve an “optimum” descent gradient.

### 10.1.2 Intermediate Approach Segment.

Establish an intermediate segment when necessary (e.g., ATC radar vectors not available or MVA too high to support desired FAF/PFAF altitude). The intermediate segment begins at the intermediate fix and extends to the PFAF. When there is a preceding conventional / RNAV route segment, the applicable conventional/RNAV intermediate segment standards apply, except as specified in paragraph 10.1.2b(2).

a. **Alignment.** The intermediate course is an extension of the final approach course (no course change permitted at the PFAF).

b. **Area.**

   (1) **Radar Intermediate.** When radar is used for course guidance (route or vector), the OEA begins at the applicable radar fix displacement prior to the Intermediate Fix (IF) and extends to the PFAF. Primary area half-width is equal to the minimum lateral clearance applicable to the radar adaptation (e.g. 3 NM if the A/C is less than 40 NM from the antenna and 5 NM if the A/C is 40 NM or more from the antenna) until reaching a point 2 NM prior to the PFAF, then tapers to the width of the PAR Final Approach segment (FAS) primary OEA when abeam the PFAF. There are no intermediate secondary areas. See figure 10-1.

   **Note:** When the minimum lateral clearance changes within a segment (e.g. 5 NM to 3 NM), the OEA half-width also changes without the need to “splay” or “taper”.

   (2) **Non-Radar Intermediate.** When conventional/RNAV navigation is used for course guidance, apply the intermediate OEA criteria from the applicable TP308/GPH209 volume with the following exceptions:

   (a) **Connection to PAR Final.** Connect the outer edges of the intermediate primary area abeam the IF to the outer edges precision “X” Obstacle Clearance Surface (OCS) and the intermediate secondary area to the precision “Y” OCS abeam the PFAF.
(3) **Length.** The intermediate segment length is normally 6 NM. The MINIMUM length varies based on course guidance but must always accommodate the required altitude loss. The maximum length is 15 NM.

(a) For conventional/RNAV and radar route course guidance, apply Volume 1, chapter 2 for ASR approaches and Volume 3, chapter 2 for PAR approaches. Radar intermediate segments may not be less than 2 NM.

c. **Obstacle Clearance.** Apply 500 ft ROC over the highest obstacle in the area. Volume 1, chapter 3 precipitous terrain and RASS adjustments apply. For conventional/RNAV course guidance, apply secondary area ROC criteria from the applicable TP308/GPH209 Volume.

d. **Descent gradient.** Apply Volume 1, Chapter 2.

10.1.3 **PAR Final Approach Segment (FAS).**

a. **Inoperative/unused Components.** Failure of the azimuth component renders the entire PAR system inoperative. When the glide slope feature becomes inoperative, the PAR reverts to a non-precision approach system. In this case, obstacle clearance shall be as specified in Vol. 1, Chapter 9 for localizer approaches.

The missed approach instructions are the same, and the radar missed approach point is identifiable on the PAR scope. NPA minimums are established according to TP308/GPH209, Volume 1, Chapter 3, section 3 and are documented as applicable.

b. **General.** Apply the current basic vertically guided final segment general criteria applicable to Instrument Landing System (ILS) for Glidepath Angle (GPA), Threshold Crossing Height (TCH), Precise Final Approach Fix (PFAF), Glidepath Qualification Surface (GQS), and Precision Obstacle Free Zone (POFZ).

(1) Use the highest applicable MVA to determine the PFAF distance to LTP/coordinates when there is no preceding segment.

(2) ILS Height Above Touchdown/Threshold (HAT/HATH) and Decision Altitude (DA) standards apply (to include Volume 1, chapter 3 adjustments), except the minimum HAT/HATH may be 100 ft for helicopter approaches when the OCS is clear.

Note: Adjusting TCH to reduce/eliminate OCS penetrations is not applicable to PAR FAS evaluations.

c. **Obstacle Evaluation Area (OEA)/Obstacle Clearance Surface (OCS).** Apply current ILS FAS criteria for alignment, OCS slope, width, height, and OEA/OCS evaluation except the OEA extends to the PFAF (no radar fix tolerance applied). Also, where the PFAF must be located more than 50200 ft from the RWT coordinates, the OEA continues to splay to the PFAF or until reaching the minimum lateral clearance applicable to the radar adaptation.
10.1.4 Missed Approach Segment (MAS).

a. PAR. Apply the Volume 3 Category (CAT) I ILS missed approach criteria to approaches with HAT/HATH values greater than or equal to 200 ft. Apply CAT II missed approach criteria for approaches with HAT/HATH values lower than 200 ft.

Figure 10-1: Intermediate Segment Area
CHAPTER 11. RESERVED
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CHAPTER 12. DEPARTURE PROCEDURES

1200. General
These criteria specify the obstacle clearance requirements to be applied to diverse departures and departure routes. Obstacle identification surfaces (OIS) of 40:1 are used. A climb gradient of 200 feet per NM will provide at least 48 feet per NM of clearance above objects, which do not penetrate the OIS. Objects which penetrate the OIS are obstacles and shall be considered in the departure procedure by specifying a flight path which will safely avoid the obstacle(s) or by specifying a climb gradient greater than 200 feet per NM that will provide 48 feet (24%) of required obstacle clearance (ROC) for each NM of the flight path. Take-off visibility minima (SPEC VIS) and a visual climb to altitude shall be established for those departures specifying a climb gradient (unless authorized by Transport Canada Standards).

1201. Application
Diverse departure criteria (Para 1202) shall be applied to all runways authorized by the approving authority for instrument departures. Application of diverse departure criteria may result in the need to develop specific departure routes to avoid obstacles (Para 1203).

1202. Diverse Departures
At many airports, a prescribed departure route is not required for ATC purposes nor as the only suitable route to avoid obstacles. In spite of this, there may be obstacles in the vicinity of the airport that should be considered in determining that restrictions to departures are to be prescribed in a given section(s). The areas and surfaces described herein are to be used to identify such obstacles. Sectors shall be described by bearings and distance from the airport reference point which diverge at least 15° either side of the controlling obstacle. Departure restrictions shall be published as described in Para 1207.a.

a. Zone 1.
(1) Area. The area begins at the departure end of the runway (DER) and has a beginning width of 1,000 feet (+/- 500 feet from centreline). The area splays 15° on each side of the extended runway centreline for a distance of 2 NM from the DER (see Figure 12–116A).

(2) Obstacle Identification Surface. A 40:1 OIS overlies Zone 1. It begins at the DER, at the DER altitude and rises in the direction of departure. Obstacle distance measurements shall be made by projecting a line from the obstacle to intersect the extended runway centreline at 90°. The distance from this intersect point to the DER shall be considered the obstacle distance.

b. Zone 2.
(1) Area. Zone 2 extends radially from a point on the runway centreline located 2,000 feet from the start end of the runway. It is centred on the extended take-off surface centreline and excludes Zone 1. It extends the distance necessary for the 40:1 OIS to reach the minimum altitude authorized for en-route operations (see Figure 12–116B).

(2) Obstacle Identification Surface. A 40:1 OIS overlies Zone 2 and has a beginning height equal to the height of the OIS at the end of Zone 1. Distance measurements to an obstacle shall be made from the runway edge or edge of Zone 1, whichever in the shorter distance.
c. Zone 3.

(1) **Area.** Zone 3 covers the area in the direction opposite to the take-off beginning 2,000 feet from the start end of the runway. It provides clearance for 180° turn departures and extends the distance necessary for the 40:1 OIS to reach the minimum altitude authorized for en-route operations (see Figure 12–116C).

(2) **Obstacle Identification Surface.** A 40:1 OIS overlies Zone 3 and begins 400 feet above airport elevation along the runway edge and rises there from.

**1203. Departure Routes**

There are three basic types of departure routes: straight, turning, and combination straight and turning. Departure routes shall be based on positive course guidance acquired within 10 NM from the DER on straight departures and within 5 NM after completion of turns on departures requiring turns. Surveillance radar, when available, may be used to provide positive course guidance.

a. **Straight Departures.** A straight departure is one in which the initial departure course is within 15° of the alignment of the take-off surface. Additionally, the departure course must intersect the runway centreline extended within 2 NM from the DER or the departure course must lie within 500 feet laterally of the runway centreline at the DER (see Figures 12–116D to 12–116H). When the initial departure course is to a facility, a manoeuvring segment is provided under the provisions of Para 1203.a.(1)(b).

(1) **Area.** The area begins at the departure end of the runway. It is based on the departure course and has a minimum beginning width of 1,000 feet (+500 feet from centreline). The edge of the area shall be no less than 500 feet from the centreline of the runway and the departure course. For example, if the departure course lies 500 feet from the centreline, the beginning width of the area shall be no less than 1,500 feet (see Figure 12–116G). The area splays 15° on each side of the departure course and/or runway centreline extended (whichever protects the greater area) to the point where the boundaries intercept the area associated with the navaid providing course guidance.

(a) When course guidance is provided by a localizer, the area specified in Para 1202.a.(1) shall be used for the first 2 NM of the departure. This area shall be joined to the localizer final approach area stated in Para 903 by lines drawn from the extremities of the area at 2 NM from the departure threshold to the width of the localizer area at 10 NM (see Figure 12–116H). (At certain airports, localizers, although installed, may not be available for use as a departure navaid.)

(b) The area associated with the navaid (other than a localizer) providing course guidance shall have the following dimensions. It shall be 3 NM (+1.5 NM) wide at the facility, it shall have a minimum length of 10 NM and shall splay to a width of 5 NM (+2.5 NM), 6 NM (+3.0 NM) for NDB, at 10 NM from the facility. If additional distance is required, the area may be joined from its extremities to the primary en-route area using 4.5°, 5° for NDB, or splay until primary en-route width is reached.

(i) If a turn of 15° or less is required over the facility, the inbound and outbound areas outer boundaries shall be joined by an arc of 1.5 NM radius.

(ii) If a turn of more than 15° but less than 30° is required over the facility, the turning departure area outer boundary radius (Table 12–31) shall be applied to join the two areas. The outbound area outer boundary shall be applied to join the two areas. The outbound area outer boundary shall be constructed by a line tangent to the arc and drawn to the edge of the outbound area at 10 NM from the facility (see Figure 12–116I).
(iii) If a turn of 30° or more is required over the facility, the area shall be extended a distance of 1 NM beyond the facility aligned with the inbound track at a width of 3 NM (+1.5 NM) and the turning departure area outer boundary radius (Table 12–31) shall be applied to join the extension to the area associated with the outbound track. The outbound area outer boundary shall be constructed by a line tangent to the arc and drawn to the edge of the outbound area at 10 NM from the facility (see Figure 12–116J).

(2) Obstacle Identification Surface. A 40:1 OIS overlies the straight departure area and rises in the direction of departure. The OIS begins at the DER, at the DER elevation.

b. Turning Departures. If the initial departure course does not meet the criteria specified in Para 1203.a, a turning departure shall be constructed. A turning departure is one in which the aircraft climbs straight ahead on the heading of the take-off surface until reaching 400 feet above the airport elevation (within 2 NM) and then immediately begins a turn to intercept a departure course. Positive course guidance is required within 5 NM after completion of the turn (see Figure 12–116K).

(1) Area. The turning departure area is divided into Sections 1 and 2.

(a) Section 1 is identical to the 15° splay area specified in Para 1203.a.(1). It terminates 2 NM from the beginning of the 15° splay area.

(b) Section 2 starts at the end of Section 1. The flight track and outer boundary radii shall be determined from Table 12–31. The outer boundary line shall splay 15° from the departure course beginning at the point abeam the point where the turn is completed. The inner boundary line shall begin at the runway edge 2,000 feet from the start end of the take-off surface on the side in the direction of the turn (Point D). It terminates at the same distance abeam the departure course as the outer boundary does at the end of the departure. The splay of Section 2 terminates when the width reaches that of the primary en-route structure. Thereafter, en-route criteria apply.

(2) Obstacle Identification Surface

(a) Section 1. A 40:1 OIS overlies Section 1 and is identical to the 40:1 specified in Para 1203.a.(2).

(b) Section 2. The dividing line between Sections 1 and 2 are identified as “AB, BC, CD”. A 40:1 OIS overlies Section 2 and has an initial height equal to the terminating height of Section 1 at any point along the dividing line and rises in the direction of the departure course. The height of the OIS at any point in Section 2 is determined by measuring the straight line distance from this point to the nearest point on the “AB, BC, CD” dividing line.
c. **Combination Straight and Turning Departure.** If a straight climb to a height, which is more than 400 feet above the elevation of the DER is necessary prior to beginning the departure turn, a combination straight and turning departure area must be applied. Whenever possible, the point at which the turn commences shall be identified by a fix or by the intersection of the initial dead reckoning departure course with a radial or bearing which provides positive course guidance. When a fix, radial or bearing is not available, the turn may be specified to commence at an altitude based on a climb gradient of 200 feet per NM. For example, a turn 1,000 feet above DER elevation shall be assumed to commence 5 NM from the end of the runway. Positive course guidance is required within 5 NM after completion of the turn.

(1) Area. The combination straight and turning departure is divided into Sections 1 and 2 (see Figure 12–116L).

(a) Section 1 is identical to the straight departure area except that it extends to the point at which the turn begins.

(b) Section 2 starts at the end of Section 1. The flight track and outer boundary radii shall be determined from Table 12–31. The outer boundary radius shall be drawn beginning a distance past the plotted position of the turning point equal to the fix error, along track accuracy, or abeam plotted position; whichever is further from the end of the departure runway. The inner boundary line shall begin at the edge of the 15° splay area at a distance prior to the plotted position of the turning point equal to the fix error or along track accuracy plot plus 1 NM. Where the turn is specified to commence at an altitude, the outer boundary radius begins at the end of Section 1, and the inner boundary line begins at the edge of the 15° splay area abeam the DER. The outer boundary line shall splay 15° from the departure course beginning at the point where the turn is completed. The inner boundary line is drawn from the point of beginning to a point which is the same distance abeam the departure course as the outer boundary is at the end of the departure.

(c) Where a turn is required to intercept a radial/bearing to proceed to or from a facility, alternate area construction is necessary (see Figure 12–116M). The appropriate flight track radius will join the radial/bearing and the runway centreline extended. The arc will be drawn from a point on the bisector of the angle between the runway centreline extended and the plotted position of the radial/bearing. Section 1 ends at the point of tangency of the extended centreline and the arc. The inner boundary begins at the near edge of Section 1 at a point 1 NM prior to the end of that section. The outer boundary begins at the intersection of the extended 15° splay line of Section 1 and the plotted position of the radial/bearing. The splay of Section 2 terminates when the width reaches that of the primary en-route structure. Thereafter, en-route width criteria apply.

(2) Obstacle Identification Surface.

(a) Section 1. A 40:1 OIS overlies the straight departure area. It begins at the DER, at the DER elevation, and rises in the direction of departure.

(b) Section 2. The dividing lines between Sections 1 and 2 are identified as "AB, BC". A 40:1 OIS overlies Section 2. It has the same height as the Section 1 OIS at the dividing line AB and rises in the direction of the departure course.
1204. Reserved

1205. Climb Gradients

Climb gradients shall include 48 feet per NM (24%) required obstacle clearance. When precipitous terrain is a factor, consideration shall be given to increasing the obstacle clearance (see Para 323). Gradients shall be specified to an altitude or fix at which a gradient of more than 200 feet per NM is no longer required. Climb Gradients in excess of 500/NM require approval of Flight Standards (or the appropriate military authority).

a. Diverse Departures. In cases where departure routes are not required to avoid obstacles, but obstacles exist in a sector(s) such as a mountain range, the required gradient shall be computed from the origin of the Zone 2 or 3 OIS (as applicable) direct to the obstacle. The altitude to which the climb gradient must be maintained is based on the obstacle plus ROC requiring the highest altitude in that sector.

b. Departure Routes. Climb gradients shall be computed from the elevation of the OIS at the DER along the shortest possible flight path within the obstacle clearance area to the obstacle.

c. Climb gradients. Where low, close-in obstacles result in climb gradient to an altitude 200 feet or less above DER elevation. Publish a note identifying obstacle(s) type, location relative to DER and ASL elevation.

1206. End of Departure

The departure area terminates at a point where the 40:1 OIS, measured along the flight track, reaches the minimum altitude authorized for en-route operations or radar vectoring, whichever is applicable. Where a climb in hold is required to achieve enroute operations, is shall be assessed in accordance with Chapter 18, Holding Criteria. The departure instructions shall specify a climb in hold altitude that is equivalent to an enroute altitude; or the instructions shall specify a climb in hold altitude that will ensure that after leaving the hold and proceeding on course, the 40:1 OIS will be clear until achieving the enroute ROC.
1207. Published Information

The minimum information to be published for departure procedures is specified as follows:

a. Diverse Departures. Departure restrictions shall be expressed as sectors to be avoided or sectors in which climb gradients and/or minimum altitudes are specified to enable an aircraft to safely overfly an obstacle. When more than one sector is involved, the climb gradient selected shall be the highest in any sector that may be expected to be overflown. The altitude to which the gradient is specified must permit the aircraft to continue at 200 feet per NM minimum through that sector, a succeeding sector, or to an en-route altitude. A fix may also be designated to mark the point at which a climb gradient in excess of 200 feet per NM is no longer required.

b. Departure Routes. A departure route must specify all courses, points, fixes, and altitudes required in the procedure. When obstacles must be overflown, minimum crossing altitudes and climb gradient information shall be provided for all departures requiring a climb gradient greater than 200 feet per NM. The altitude or fix at which a climb gradient in excess of 200 feet per NM is no longer required shall also be specified.

c. Minima imposed shall be in accordance with Para 1208 and Chapter 3.

d. When departures are limited to a specific category of aircraft, i.e. Cat A and B, Cat A, B & C, the procedure shall be clearly annotated.

1208. Required Minima

IFR departure procedures requiring a climb gradient in excess of 200 feet per NM to meet obstacle clearance requirements shall have published "SPEC VIS" (SPECIFIED TAKE-OFF MINIMUM VISIBILITY) and a visual climb to altitude (i.e. Visual Climb Over Airport (VCOA) maneuver) to accommodate aircraft that cannot meet the required climb gradient.

Supplementary Note: It is possible that VCOA operations may be deemed impractical or even a detriment to the overall performance of certain high traffic density aerodromes. Should this be the case and the aerodrome has 24 hr control tower service in Class B, C or D controlled airspace, then the aerodrome may be exempt from the requirement to build a VCOA. A note stating the above shall be required in the design documentation.

1209. Visual Climb Over Airport (VCOA)

Option to allow an aircraft to climb over the airport with visual reference to obstacles to attain a suitable altitude from which to proceed with an IFR departure.

1210. Visual Climb Area (VCA)

Construct this area in the same manner as the circling approach area described in Para 260.a, using the radii in Table 12–32. Elimination of sectors as per para 261 does not apply.

Supplementary Note: From an operational point of view the title Visual Climb Area is misleading as the aircraft is not required to climb solely within this “cylinder”. The pilot is only required to depart from within this area at or above the climb-to altitude, after visually maneuvering his aircraft into position.

1211. Establishment Of Altitude For Visual Climb Area

To determine the preliminary climb-to altitude for the VCA, add 264 feet, plus any Para 323. b adjustments, to the highest obstacle in the VCA. Round the resultant altitude to the next higher
100-foot increment. If this altitude does not support en-route flight, evaluate a straight departure area using a 40:1 obstacle identification surface.

1212. Straight Departure Area

a. This area begins over the airport reference point (or on-airport navaid). Area width is appropriate to the navaid used, as defined in Para 1203.a.(1)(b).

b. When DR is used, the area has the same width as the VCA abeam the point of beginning. The DR area begins over the airport reference point. The splay begins where a line constructed perpendicular the DR course and through the Aerodrome Geometric Centre (AGC) intercepts the VCA boundary. It splays 15° each side of and in the direction of the DR course until positive course (track) guidance is acquired (see Figure 12–117).

c. For straight-out segment evaluations, determine the 40:1 surface beginning height by subtracting 264 feet, plus any Para 323.b adjustments, from the computed climb-to altitude. The 40:1 surface begins at the VCA boundary, and rises in the shortest distance to the obstacle being evaluated. Where penetrations exist, increase the climb-to altitude by the greatest amount of penetration rounded to the next higher 100-foot increment.

1213. Published Annotations

The procedure must include instructions to climb in visual conditions to cross a location/fix at or above the climb to altitude determined during the evaluation of the procedure.

a. For a VCOA diverse departure, include the term, “before proceeding on course” (BPOC) following the climb to altitude.

Example:

(1) “Climb in visual conditions to cross the airport at or above 2200 BPOC.”

b. For a VCOA route departure, specify the visual climb to altitude, then the initial heading or track followed by the routing.

Examples:

(1) “Climb in visual conditions to cross the airport at or above 4200, then climb on track of 125° to ABC VOR BPOC”

-or-

(2) “Climb in visual conditions to cross the airport eastbound at or above 5000, then via LEX R-281 to LEX”
### 1214—1299. Reserved

<table>
<thead>
<tr>
<th>Turn Altitude (feet MSL)</th>
<th>Flight Track Radius (R₁) (NM)</th>
<th>Outer Boundary Radius (R) (NM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAT A &amp; B</td>
<td>Others</td>
</tr>
<tr>
<td>S.L. to 1,000</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>1,001 to 3,500</td>
<td>1.2</td>
<td>2.7</td>
</tr>
<tr>
<td>3,501 to 6,000</td>
<td>1.3</td>
<td>2.9</td>
</tr>
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<td>3.1</td>
</tr>
<tr>
<td>Above 8,501</td>
<td>1.6</td>
<td>3.4</td>
</tr>
</tbody>
</table>

**Note:** These turn radii will accommodate speeds up to 350 KIAS with 30° angle of bank. Outer boundary radius may be reduced ½ NM operational advantage. Procedure must be annotated with airspeed restriction 250 KIAS.

Table 12-1: Departure Turn Radii. Para 1203.a.(1) (b), 1203.b.(1)(b), and 1203.c.(1)(b).

<table>
<thead>
<tr>
<th>Category</th>
<th>Radius (NM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
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</tr>
<tr>
<td>B</td>
<td>2.5</td>
</tr>
<tr>
<td>C</td>
<td>2.7</td>
</tr>
<tr>
<td>D</td>
<td>3.3</td>
</tr>
<tr>
<td>E</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Table 12-2: Visual Climb Area Radii. Para 1210.
Figure 12-116A: Zone 1 Diverse Departure. Para 1202.a.
Figure 12-116B: Zone 2 Diverse Departure. Para 1202.b.
Figure 12-116C: Zone 3 Diverse Departure. Para 1202.c.
Figure 12-116D: Straight Departure Area Without Course Guidance. Para 1203.
Supplementary Note: The Splay is 6 NM for NDB at 10 NM from the facility.
Figure 12-116F: Straight Departure With Course Guidance From Off Aerodrome Facility. Para 1203.

Supplementary Note: The Splay is 6 NM for NDB at 10 NM from the facility.
Figure 12-116G: Straight Departure With Offset Departure Course. Para 1203.

Figure 12-116H: Departure Area When Localizer Is Used For Course Guidance. Para 1203.
Figure 12-116I: Turn of More Than 15° But Less Than 30° Over Facility. Para 1203.a.
Figure 12-116J: Turn Of 30° Or More Over Facility. Para 1203.a. (1).
Figure 12-116K: Turning Departure. Para 1203.b.
Figure 12-116L: Combination Straight And Turning Departure. Para 1203.c.
Figure 12-116M: Combination Straight And Turning Departure (To Intercept Radial Or Bearing). Para 1203.c.
Figure 12-117: Variations Of DR Straight Departure Areas. Para 1212.b.
Figure 12-118: Variations Of A Straight Departure Area To A NAVAID. Para 1212 and 1213.

**Supplementary Note:** Add Para 323b to ROC.
CHAPTER 13. RESERVED
INTENTIONALLY
LEFT
BLANK
CHAPTER 14. RESERVED
INTENTIONALLY LEFT BLANK
CHAPTER 15. RESERVED
INTENTIONALLY LEFT BLANK
CHAPTER 16. RESERVED
CHAPTER 17. EN ROUTE CRITERIA

1700—1709. Reserved

SECTION 1. VHF OBSTACLE CLEARANCE AREAS

1710. En Route Obstacle Clearance Areas

Obstacle clearance areas for en route planning are identified as "primary", "secondary", and turning areas.

1711. Primary Areas

a. Basic Area. The primary en route obstacle clearance area extends from each radio facility on an airway or route to the next facility. It has a width of 8 NM; 4 NM on each side of the centreline of the airway or route (see Figure 17-1).

b. System Accuracy. System accuracy lines are drawn at a 4.5° angle on each side of the course or route (see Figure 17-1). The apexes of the 4.5° angles are at the facility. These system accuracy lines will intersect the boundaries of the primary area at a point 50.8 NM from the facility. (Normally 51 NM is used.) If the distance from the facility to the change over point (COP) is more than 51 NM, the outer boundary of the primary area extends beyond the 4 NM width along the 4.5° lines (see Figure 17-2). These examples apply when the COP is at mid point. Para 1716 covers the effect of offset COP or dogleg segments.

c. Termination Point. When the airway or route terminates at a navigational facility or other radio fix, the primary area extends beyond that termination point. The boundary of the area may be defined by an arc which connects the two boundary lines. The centre of the arc is, in the case of a facility termination point, located at the geographic location of the facility. In the case of a termination at a radial or DME fix, the boundary is formed by an arc with its centre located at the most distant point of the fix displacement area on course line. Figure 17-8 and its inset show the construction of the area at the termination point.

1712. Secondary Areas

a. Basic Area. The secondary obstacle clearance area extends along a line drawn 2 NM on each side of the primary area (see Figure 17-3).

b. System Accuracy. Secondary area system accuracy lines are drawn at a 6.7° angle on each side of the course or route (see Figure 17-3). The apexes are at the facility. These system accuracy lines will intersect the outer boundaries of the secondary areas at the same point as primary lines, 51 NM from the facility. If the distance from the facility to the COP is more than 51 NM the secondary area extends along the 6.7° line (see Figure 17-4 and Para 1716.c. and d. for offset COP or dogleg airway).

c. Termination Point. Where the airway or route terminates at a facility or radio fix the boundaries are connected by an arc in the same way as those in the primary area. Figure 17-8 and its inset show termination point secondary areas.
1713. Turning Segments

a. Definition. The en route turning area may be defined as an area, which may extend the primary and secondary obstacle clearance areas when a change of course is necessary. The dimensions of the primary and secondary areas will provide adequate protection where the aircraft is tracking along a specific radial, but when the pilot executes a turn, the aircraft may go beyond the boundaries of the protected airspace. The turning area criteria supplements the airway and route segment criteria to protect the aircraft in the turn.

b. Requirement for Turning Segment Criteria. Because of the limitation on aircraft indicated air speeds below 10,000 feet MSL some conditions do not require the application of turning area airspace criteria.

(1) The graph in Figure 17-5 may be used to determine if the turning segment should be plotted for airways/routes below 10,000 feet MSL. If the point of intersection on the graph of the "amount of turn at intersection" versus "VOR facility to intersection distance" falls outside the hatched area of the graph, the turning segment criteria need not be applied.

(2) If the "amount of turn" versus "facility distance" values fall within the hatched area or outside the periphery of the graph, then the turning segment criteria must be applied as described in Para 1714.

c. Track. The flight track resulting from a combination of turn delay, inertia, turning rate, and wind effect is represented by a parabolic curve. For ease of application, a radius arc has been developed which can be applied to any scale chart.

d. Curve Radii. A 250-knot IAS, which is maximum allowed below 10,000 feet MSL, results in radii of 2 NM for the primary area and 4 NM for the secondary area up to that altitude. For altitudes at or above 10,000 feet MSL up to but not including 18,000 feet MSL the primary area radius is 6 NM and the secondary area radius is 8 NM. At and above 18,000 feet MSL the radii are 11 NM for primary and 13 NM for secondary.

e. System Accuracy. In drawing turning segments it will be necessary to consider system accuracy factors by applying them to the most adverse displacement of the radio fix or airway/route boundaries at which the turn is made. The 4.5 and 6.7° factors apply to the VOR radial being flown but since no pilot or aircraft factors exist in the measurement of an intersecting radial, a navigation facility factor of plus-or-minus 3.6° is used (see Figure 17-6).

Note: If a radio fix is formed by intersecting signals from two LF, or one LF and VOR facility, the obstacle clearance areas are based upon accuracy factors of 5.0° (primary) and 7.5° (secondary) each side of the course or route centreline of the LF facilities. If the VOR radial is the intersecting signal, the 3.6° value stated in Para 1713.e applies.
1714. Application Of Turning Segment Criteria

a. **Techniques.** Figures 17-8, 17-9, and 17-10 illustrate the application of the criteria. They also show areas which may be deleted from considerations when obstacle clearance is the deciding factors for establishing minimum en route altitudes (MEAs) on airways or route segments.

b. **Computations.** Computations due to obstacles actually located in the turning segments will probably be indicated only in a minority of cases. These methods do, however, add to the flexibility of procedures designers in resolving specific obstacle clearance problems without resorting to the use of deviations to procedures.

c. **Minimum Turning Altitude** (MTA). Where the application of the turn criteria obviates the use of an MEA with a cardinal altitude, the use of an MTA for a special direction of flight may be authorized.

1715. Turn Area Template

A turn area template has been designed for use on charts scaled at 1:500,000 (see Figure 17-7). It is identified as a “TA-1.”

a. **Use of Template Intersection Fix.**

   (1) **Primary Area.** At an intersection fix the primary obstacle clearance area arc indexes are placed at the most adverse points of the fix displacement area as determined by the outer intersections of the en route radial 4.5° lines (VOR) and the cross-radial 3.6° lines (VOR) (see Figures 17-8 and 17-9). If LF signals are used the 5.0° system accuracy lines apply. The parallel dashed lines on the turn area template are aligned with the appropriate system accuracy lines and the curves are drawn.

   (2) **Secondary Area "Outside" Curve.** The outside curve of the secondary area is the curve farthest from the navigation facility that provides the intersecting radial. This curve is indexed to the distance from the fix to the en route facility as follows:

      (a) Where the fix is less than 51 NM from the en route facility, the secondary arc is started at a point 2 NM outside the primary index with the parallel dashed lines of the template aligned on the 4.5° lines (see Figure 17-8).

      (b) Where the fix is farther than 51 NM from the en route station, the arc is started at the point of intersection of the 3.6 and 6.7° lines with the parallel dashed lines of the template aligned on the 6.7° lines (see Figure 17-9).

   (3) **Secondary Area "Inside" Curve.** The inside curve is the turning segment arc which is nearest the navigation facility which provides the intersecting radial. This arc is begun 2 NM beyond the primary index and on the 3.6° line. The parallel dashed lines on the turning segment template are aligned with the 4.5° lines from the en route station.

      (a) Where the fix is less than 51 NM from the en route facility and the magnitude of the turn is less than 30°, the "inside" curves do not affect the size of the secondary area.

      (b) Where the distance from the en route facility to the fix is more than 51 NM but the magnitude of the turn is less than 45°, the "inside" curves do not increase the size of the secondary area.

      (c) Where the magnitude of the turn is greater than those stipulated in (a) and (b) the "inside" curves will affect the size of the secondary area.
(d) Whether the secondary area curves affect the size of the secondary obstacle clearance area or not, they must be drawn to provide reference points for the tangential lines described in (4) below.

(4) **Connecting Lines.** Tangential straight lines are now drawn connecting the two primary arcs and the two secondary arcs. The outer limits of both curves are symmetrically connected to the respective primary and secondary area boundaries in the direction of flight by lines drawn at a 30° angle to the airway or route centreline (see Figures 17-9 and 17-10).

**b. Use of Template When Fix Overheads A Facility** (see Figure 17-10). The geographical position of the fix is considered to be displaced laterally and longitudinally by 2 NM at all altitudes.

(1) **Primary Arcs.** The primary arcs are indexed at points 2 NM beyond the station and 2 NM on each side of the station. The parallel dotted lines on the template are aligned with the airway or route boundaries and the curves drawn.

(2) **Secondary Arcs.** The secondary arcs are indexed 2 NM outside the primary points, and on a line with them. The parallels dotted lines on the template are aligned with the airway or route boundaries and the curves drawn.

(3) **Connection Lines.** Tangential straight lines are now drawn connecting the two primary and the two secondary arcs. The outer limits of both curves are connected to the primary and secondary area boundaries by intercept lines, which are drawn 30° to the airway or route centreline. The 30° lines on the template may be used to draw these intercept lines.

**c. Deletion Areas.** Irregular areas remain on the outer corners of the turn areas (see Figures 17-8, 17-9, and 17-10). These are the areas identified in Para 1714 which may be deleted from consideration when obstacle clearance is the deciding factor for determination of MEA on an airway or route segment.

(1) Where the "outside" secondary area curve is started within the airway or route secondary area boundary (see Figure 17-8), the area is blended by drawing a line from the point where the 3.6° (5.0° with LF facility) line meets the line which forms the en route secondary boundary tangent to the "outside" secondary arc. Another line is drawn from the point where the same 3.6° (or 5.0°) line meets the line, which forms the primary boundary, tangent to the matching primary arc. These two lines now enclose the secondary area at the turn. The corner, which was formerly part of the secondary area, may be disregarded; the part, which was formerly part of the primary area, may now be considered secondary area. These areas are shaded in Figure 17-8.

(2) Where the secondary curve is indexed on the secondary area boundary formed by the 6.7° lines, the arc itself cuts the corner and prescribes the deleted area (see Figure 17-9). This condition occurs when the radio fix is over 51 NM from the en route navigation facility.

(3) When overheading the facility, the secondary area corner deletion area is established by drawing a line from a point opposite the station index at the secondary area boundary, tangent to the secondary "outside" curve (see Figure 17-10). A similar line is drawn from a point opposite the station index at the primary area boundary, tangent to the primary turning arc. The corner formerly part of the primary area now becomes secondary area. Shading in Figure 17-10 shows the deletion areas.
1716. Change Over Points (COP)

Points have been defined between navigation facilities along airway/route segments, which are called "change over points (COP)". These points indicate that the pilot using the airway/route should "change over" the navigation equipment to receive course guidance from the facility ahead of the aircraft instead of the one behind. These COP divide a segment and assure continuous reception of navigation signals at the prescribed minimum enroute IFR altitude (MEA). They also assure that aircraft operating within the same portion of an airway or route segment will not be using azimuth signals from two different navigation facilities. Where signal coverage from two facilities overlaps at the MEA, the COP will normally be designated at the mid point, and is not shown on the chart. Where radio frequency interference or other navigation signal problems exist, the COP will be at the optimum location, taking into consideration the signal strength, alignment error, or any other known condition, which affects reception. The effect, of COP on the primary and secondary obstacle clearance areas is as follows:

a. **Short Segments.** If the airway or route segment is less than 102 NM long and the COP is placed at the mid point, the obstacle clearance areas are not affected (see Figure 17-11).

b. **Long Segments.** If the distance between two facilities is over 102 NM and the COP is placed at the mid point, the system accuracy lines extend beyond the minimum widths of 8 and 12 NM, and a flare results at the COP (see Figure 17-12).

c. **Offset Cop.** If the change over point is offset due to facility performance problems, the system accuracy lines must be carried from the farthest facility to a position abeam the change over point, and these lines on each side of the airway or route segment at the COP are joined by lines drawn from the nearer facility. In this case the angles of the lines drawn from the nearer facility have no specific angle (see Figure 17-13).

d. **Dogleg Segment.** A dogleg airway or route segment may be treated in a manner similar to that given offset COPs. The system accuracy lines will be drawn to meet at a line drawn as the bisector of the dogleg "bend" angle and the boundaries of the primary and secondary areas extended as required (see Figure 17-14).

1717. Course Change Effect

The complexity of defining the obstacle clearance areas is increased when the airway or route becomes more complex. Figure 17-15 shows the method of defining the primary area when a radio fix and a COP are involved. Note that the system accuracy lines are drawn from the farthest facility first, and govern the width of the airway or route at the COP. The application of secondary area criteria results in a segment similar to that depicted in Figure 17-16.

1718. Reserved

1719. Protected En Route Areas/Segments

As previously established, the en route areas, which must be considered for obstacle clearance protection, are identified as primary and secondary turn areas. The overall consideration of these areas is necessary when determining obstacle clearances.
SECTION 2. VHF OBSTACLE CLEARANCE

1720. Obstacle Clearance, Primary Area

a. Non-Mountainous Regions. The minimum obstacle clearance over areas not designated as, mountainous will be 1,000 feet over the highest obstacle.

b. Mountainous Areas. Owing to the action of Bernoulli Effect and of atmospheric eddies, vortices, waves, and other phenomena, which occur in conjunction with the disturbed airflow attending the passage of strong winds over mountains, pressure deficiencies manifested as very steep horizontal pressure gradients develop over such regions. Since down drafts and turbulence are prevalent under these conditions, the hazards to air navigation are multiplied. Except as set forth in (1) below, the minimum obstacle clearance over terrain and manmade obstacles, within designated mountainous regions will be 2,000 feet.

(1) Obstacle clearance may be reduced to not less than 1,500 feet above terrain and manmade obstacles within the designated mountainous regions located in eastern Canada which includes part of Quebec, New Brunswick and Newfoundland as described in TP 1820 DAH/GPH 204.

Note: Altitudes of 1,000 feet of obstacle clearance within designated mountainous regions may be provided on airways/routes located within terminal areas. That segment is to be identified by a fix or facility.

1721. Obstacle Clearance, Secondary Areas

In all areas, mountainous and non-mountainous, obstacles which are located in the secondary areas will be considered as obstacles to air navigation when they extend above the secondary obstacle clearance plane. This plane begins at a point 500 feet above the obstacles upon which the primary obstacle clearance area MOCA is based, and slants upward at an angle which will cause it to intersect the outer edge of the secondary area at a point 500 feet higher (see Figure 17-17). Where an obstacle extends above this plane, the normal MOCA shall be increased by adding to the MSL height of the highest penetrating obstacle in the secondary area the required clearance (C), computed with the following formula:

\[
\frac{D_1}{D_2} = \frac{500}{C} \quad \text{or} \quad C = \frac{500 \times D_2}{D_1}
\]

\(D_1\) is the total width of the secondary area.

\(D_2\) is the distance from the obstacle to the OUTER edge of the secondary area.

Note: Add an extra 1,000 feet in mountainous regions where 2,000 feet of obstacle clearance is provided and 500 feet in the region where 1,500 feet of obstacle clearance is provided.

\(D_1\) has a total width of 2 NM, or 12,152 feet out to a distance of 51 NM from the en route facility, and then increases at a rate of 236 feet for each additional NM.
Example: An obstacle which reaches 1,875 feet MSL is found in the secondary area 6,170 feet inside the outer secondary area boundary and 46 NM from the facility (see Figures 17-17 and 17-18).

\[
\begin{align*}
D_1 & = 12,152 \text{ feet} \\
D_2 & = 6,170 \text{ feet} \\
\frac{500 \times 6,170}{12,152} & = 253.8 \text{ (254 feet)} \\
\text{Obstacle height (1,875)} + 254 & = 2,129. \\
\text{MOCA is 2,200 feet.}
\end{align*}
\]

1722. Obstacle Clearance Graph

Figure 17-19 is a secondary area obstacle clearance graph, designed to allow the determination of clearance requirements without using the formula. The left axis shows the required obstacle clearance; the lower axis shows the distance from the outer edge of the secondary area to the obstacle. The slant lines are facility distance references.

Facility distances, which fall between the charted values, may be found by interpolation along the vertical distance lines.

a. Application. To use the secondary area obstacle clearance chart, enter with the value representing the distance from the outer edge of the secondary area to the obstacle. In the problems above this distance was 6,170 feet. Proceed up to the "51 NM or less" line and read the clearance requirement from the left axis. The chart reads 254 feet, the same as was found using the formula. To solve the second problem, re-enter the chart at 6,170 feet and move vertically to find 68 NM between the 60 and 70 NM facility distance slant lines. The clearance requirement shown to the left is 191 feet, the same as found using the formula.

b. Finding the MOCA. The required clearance, found by using the graph, is now added to the MSL height of the obstacle to get the MOCA.

(1) 46 NM from facility:
\[254 + 1,875 = 2,129 \text{ (2,200 MSL).}\]

(2) 68 NM from facility:
\[191 + 1,875 = 2,066 \text{ (2,100 MSL).}\]

1723—1729. Reserved
SECTION 3. ALTITUDES

1730. Minimum Reception Altitudes (MRA)

It is necessary to establish MRAs in all cases where designated intersections along airways or routes are formed by intersecting radials that require higher altitudes for the reception of that radial than the established MEA along the airway or route segment.

1731. En Route Minimum Holding Altitudes

The criteria contained herein deal with the clearance of holding aircraft from obstacles.

a. Area. The primary obstacle clearance area for holding shall be based on the appropriate holding pattern airspace area specified in Chapter 18. No reduction in the pattern sizes for "on-entry" procedures is permitted. In addition, when holding is at an intersection fix, the selected pattern shall also be large enough to contain at least 3 corners of the fix displacement area (see Paras 284 and 285, and Figure 18-2). A secondary area 2 NM wide surrounds the perimeter of the primary area.

b. Obstacle Clearance. The minimum obstacle clearance of the route shall be provided throughout the primary area. In the secondary area 500 feet of obstacle clearance shall be provided at the INNER edge, tapering to zero feet at the outer edge. For computation of obstacle clearance in the secondary area, the computational formula specified in Para 1721 shall be applied. Allowance for precipitous terrain should be considered as stated in Para 323.a. The altitudes selected by application of the obstacle clearance specified shall be rounded to the next higher 100-foot increment.

c. Communications. The communications on appropriate ATC frequencies (as determined by ATS) shall be required throughout the entire holding pattern area from the MHA up to and including the maximum holding altitude. If the communications are not satisfactory at the minimum holding obstacle clearance altitude, the MHA shall be authorized at an altitude where the communications are satisfactory.

1732. Minimum En Route Altitudes (MEA)

An MEA will be established for each segment of an airway/route from radio fix to radio fix. The MEA will be established based upon obstacle clearance over the terrain or over manmade objects, adequacy of navigation facility performance, and communications requirements. The MEA shall also be at or above the base of controlled airspace. Segments are designated West to East and South to North. Altitudes will be established to the nearest 100-foot increment; i.e. 4,049 feet becomes 4,000 feet; and 4,050 feet becomes 4,100, as long as the minimum required obstacle clearance is not violated.

Note: Care must be taken to insure that all MEAs based upon flight inspection information have been corrected to and reported as true altitudes above mean sea level (MSL).

1733—1739. Reserved
SECTION 4. NAVIGATION GAP

1740. Navigational Gap Criteria

Where a gap in course guidance exists, an airway or route segment may be approved in accordance with the criteria set forth in Para 1740.c, provided:

a. Restrictions.

(1) The gap may not exceed a distance which varies directly with altitude from zero NM at sea level to 65 NM at 45,000 feet MSL;

(2) Not more than one gap may exist in the airspace structure for the airway/route segment;

(3) A gap may not occur at any airway or route turning point, except when the provisions of Para 1740.b.(2) are applied; and

(4) Where the MEA has been established with a gap in navigational signal coverage, the gap area will be identified by distance from the navigation facilities on the chart, depicting the airway/route segments.

b. Authorization. MEAs with gaps shall be authorized only where a specific operational requirement exists. Where gaps exceed the distance in Para 1740.a.(1), or are in conflict with the limitations in Para 1740.a.(2) or (3), the MEA must be increased as follows:

(1) For straight segments:

   (a) To an altitude which will meet the distance requirement of Para 1740.a.(1), or;

   (b) When in conflict with Para 1740.a.(1) or (2) to an altitude where there is continuous course guidance available.

(2) For turning segments. Turns to intercept radials with higher MEAs may be allowed provided;

   (a) The increase in MEA does not exceed 1500 feet; and

   (b) The turn does not exceed 90°.

(3) When in conflict with Para 1740.b.(1) or (2) to an altitude where there is continuous course guidance available.

c. Use Of Steps. Where large gaps exist which require the establishment of altitudes that obviate the effective use of airspace, consideration may be given to the establishment of MEA "steps". These steps may be established at increments of not less than 2,000 feet below 18,000 feet MSL, or not less than 4000 at 18,000 and above, provided that a total gap does not exist for the segment within the airspace structure. MEA steps shall be limited to one step between any two facilities to eliminate continuous or repeated changes to altitude in problem areas. MEA changes shall be identified by designated radio fixes.
d. **Gaps.** Allowable navigational gaps may be determined by reference to the graph in Figure 17-23.

**EXAMPLE:** The problem drawn on the chart shows the method used to determine the allowable gap on a route segment with a proposed MEA of 27,000 feet. Enter the graph at the left edge with the MEA of 27,000 feet. Move to the right to the interception of the diagonal line. Move to the bottom of the graph to read the allowable gap. In the problem drawn, a 39 NM gap is allowable.

1741—1749. *Reserved*
SECTION 5. LOW FREQUENCY AIRWAYS OR ROUTES

1750. LF Airways Or Routes

a. Usage. LF navigation facilities may be used to establish en route airway/route segments.

b. Obstacle Clearance Areas (see Figures 17-24 and 17-25).

(1) The primary obstacle clearance area boundaries of LF segments are lines drawn 4.34 NM (5 statute miles) on each side of and parallel to the segment centreline. These boundaries will be affected by obstacle clearance area factors shown in Para 1750.c.

(2) The LF secondary obstacle clearance areas extend laterally for an additional 4.34 NM on each side the primary area. The boundaries of the secondary areas are also affected by the obstacle clearance areas factors shown in c. below.

c. Obstacle Clearance Area Factors (see Figures 17-24 and 17-25).

(1) The primary of LF segments is expanded in the same way as for VHF airways/routes. Lines are drawn at 5° off the course centreline from each facility. These lines meet at the mid point of the segment. Penetration of the 4.34 NM boundary occurs 49.61(50) NM from the facility.

(2) The secondary areas are expanded in the same manner as the secondary areas for VHF airways/routes. Lines are drawn 7.5° on each side of the segment centreline. These 7.5° lines will intersect the original 8.68 NM secondary area boundaries at 65.93 (66) NM from the facility.

d. Obstacle Clearance

(1) Obstacle clearance in the primary area of LF airways or routes is the same as that required for VOR airways/routes. The areas over which the clearances apply are different, as shown in Para 1750.c.

(2) Secondary area obstacle clearance requirements for LF segments are based upon distance from the facility and location of the obstacle relative to the inside boundary of the secondary area.

(a) Within 25 NM of the facility the obstacle clearance is based upon a 50:1 plane drawn from the primary area boundary 500 feet above the obstacle, which dictates its MOCA and extending to the edge of the secondary area. When obstacles penetrate this 50:1 plane, the MOCA for the segment will be increased above that dictated for the primary area obstacle as detailed in Table 17-1.

(b) Beyond the 25 NM distance from the facility, the secondary obstacle clearance plane is flat. This plane is drawn from the primary area boundary 500 feet above the obstacle, which dictates its MOCA and extending to the edge of the secondary area. If an obstacle penetrates this surface the MOCA for the segment will be increased so as to provide 500 feet of clearance over the obstacle (see Figure 17-27 and Para 1750.d.(2)(c)).

(c) Obstacle clearance values shown in (a) and (b) above are correct for non-mountainous, areas only. For areas designated as mountainous add 1,000 feet, or 500 feet, as applicable.
1751. LF/MF Facility to VHF/UHF Facility Airway or Air Route

Airways and air routes may be constructed between LF/MF and VHF/UHF facilities. The criteria for area construction and obstacle clearances are contained in the appropriate section within this chapter. However, due to the different system accuracies (primary area 4.5° for VHF/UHF and 5.0° for LF/MF and secondary area 6.7° for VHF/UHF and 7.5° for LF/MF), to ensure proper obstacle assessment for the entire airway or air route, primary and secondary LF/MF system accuracy criteria shall be applied for the entire length of the airway or air route between the LF/MF and VHF/UHF facility.

This means that when constructing the airway or air route, the LF/MF primary obstacle clearance area of 4.34 NM each side of centerline and the secondary obstacle clearance area of 4.34 NM each side of the primary area shall be applied for the entire airway or air route. In addition, the LF/MF primary area shall be expanded 5.0° off the course centerline from each facility and the secondary area shall be expanded 7.5° off the course centerline from each facility for the entire airway or air route.

1752. Application Of Variation To Calculate LF/MF Tracks

When calculating airway or air route tracks, the appropriate variation shall be applied to the LF/MF segment true bearing to ensure that the aircraft will be positioned on the desired inbound radial at the COP. Proper application of variation is necessary to minimize track error and to ensure the aircraft is positioned on course at the changeover point. This calculation is made from facility to facility and NOT redone for each airway segment between fixes.

If midpoint variation were to be used (see Figure 17-29A) this does not happen. The aircraft heading would initially overcorrect, based on the difference between local variation at the site and the midpoint variation. This over correction will decrease as the aircraft proceeds toward the midpoint, at which time the aircraft would be flying on the proper heading but has not corrected back to the desired track. On a long leg, the resulting track error can be greater than 20nm.

Therefore, to minimize this error and to position the aircraft on the desired track at the midpoint of the airway/air route, ¼ point variation shall be used (see Figure 17-29B). Due to the difference between the local variation at the aircrafts position and the ¼ point variation, the aircraft heading will initially overcompensate, resulting in a track error. As the aircraft proceeds, this error will decrease until at the ¼ point the aircraft will be flying the proper heading but now be just parallel to the desired track. As the aircraft proceeds toward the midpoint it will begin to correct back and ideally be on the desired track at the midpoint (see Figure 17-29B).

Using the same basic rational, in the instance of a dogleg or published COP, the variation to the LF/MF leg shall be the variation at the mid point of that particular segment (see Figure 17-29C).
In summary, the variation(s) to apply to the LF/MF track calculations shall be as follows:

a. **LF/MF to LF/MF**
   ¼ point variation (see Figure 17-29B).

b. **LF/MF to VHF/UHF**
   ¼ point variation for the LF/MF segment (see Figure 17-29C).
   The VHF/UHF Radial shall be calculated based on the calibrated variation used for that facility. These values are published in the Canada Flight Supplement, Part D.

c. **COP/Dogleg Segment**
   Mid-point variation for the LF/MF-COP segment shall be used to calculate the track (see Figure 17-29C).
   The VHF/UHF-COP segment track will be calculated in accordance with Para 1752.b.2.

1753—1759. **Reserved**
SECTION 6. MINIMUM DIVERGENCE ANGLES

1760. General

a. Governing Facility. The governing facility for determining the minimum divergence angle depends upon how the fix is determined.

(1) Where the fix is predicated on an off-course radial or bearing, the distance from the fix to the facility providing the off-course radial or bearing is used.

(2) Where the fix is predicated on the radials or bearings of two intersecting airways or routes, the distance between the farthest facility and the fix will be used to determine the angle.

b. Holding. Where holding is to be authorized at a fix, the minimum divergence angle is 45°.

1761. VHF Fixes

a. The minimum divergence angle for those fixes formed by intersecting VHF radials are determined as follows:

(1) When both radio facilities are located within 30 NM of the fix, the minimum divergence is 30°.

(2) When the governing facility is over 30 NM from the fix, the minimum allowable angle will be increased at the rate of 1° per NM up to 45 NM (45°).

(3) Beyond 45 NM, the minimum divergence angle increases at the rate of ½° per NM.

EXAMPLE: Distance from fix to governing facility is 51 NM.

51 - 45 = 6 NM. x ½ = 3 additional degrees.

Add this 3° to the 45° required at 45 NM and get 48° minimum divergence angle at 51 NM.

b. Figure 17-28 may be used to define minimum divergence angles. Using the foregoing example, enter the chart at the bottom with the facility distance (51 NM). Move up to the “VHF Fix” conversion line. Then move to the left to read the angle – 48°.
1762. LF or VHF/LF Fixes

a. Minimum divergence angles for LF or integrated (VHF/LF) fixes are determined as follows:
   (1) When the governing facility is within 30 NM of the fix, the minimum divergence angle is 45°.
   (2) Beyond 30 NM the minimum angle must be increased at the rate of 1° for each NM, except for fixes on long over water routes where the fix will be used for reporting purposes and not for traffic separation.

   **EXAMPLE:** The distance from the governing facility is 51 NM.
   
   \[51 - 30 = 21\]
   
   Add 21° to 45° required at 30 NM to get the required divergence angle, 66°.

b. Figure 17-28 may be used to define minimum angles for LF or VHF/LF fixes. Using the foregoing example, enter at the bottom of the chart with the 51 NM distance between the facility and fix. Move up to the "LF or INTEGRATED FIX" conversion line, then left to read the required divergence angle, 66°.

1763—1799. Reserved

<table>
<thead>
<tr>
<th>Distance from Primary Boundary</th>
<th>Height added to Obstacle in the Secondary Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1 SM (0.00 – 0.87 NM)</td>
<td>500 feet</td>
</tr>
<tr>
<td>&gt; 1 – 2 SM (0.87 – 1.74 NM)</td>
<td>400 feet</td>
</tr>
<tr>
<td>&gt; 2 – 3 SM (1.74 – 2.61 NM)</td>
<td>300 feet</td>
</tr>
<tr>
<td>&gt; 3 – 4 SM (2.61 – 3.48 NM)</td>
<td>200 feet</td>
</tr>
<tr>
<td>&gt; 4 – 5 SM (3.48 – 4.34 NM)</td>
<td>100 feet</td>
</tr>
</tbody>
</table>

**Note:** See Figure 17-23 for cross section view. Also Para 1750.d.(2)(c)

**Table 17-1:** Increase To MOCA When 50:1 Obstacle Clearance Plane Penetrated. Para 1750.d.(2)(a)
Figure 17-1: Primary Obstacle Clearance Area. Para 1711.a.

Figure 17-2: Primary Obstacle Clearance Area. Para 1711.b.
Figure 17-3: Secondary Obstacle Clearance Areas. Para 1712.a.

Figure 17-4: secondary obstacle clearance areas. Application of system accuracy lines. Para 1712.b.
Figure 17-5: Turn Angle vs Distance. Para 1713.b (1) and (2).

Figure 17-6: Fix Displacement. Para 1713.e.
Figure 17-7: Turning Segment Template. Para 1715.

Figure 17-8: turning segment, intersection fix. Facility distance less than 51 nm. Para 1715.a and b.
Figure 17-9: turning segment, intersection fix. Facility distance beyond 51 nm. Para 1715.a and b.
Figure 17-10: Turning Segment Overhead The Facility. Para 1715.b.
Figure 17-11: COP effect. Short airway or route segment. Para 1716.a.

Figure 17-12: COP Effect. Long Airway Or Route Segment. Para 1716.b.
Figure 17-13: Offset COP. Para 1716.c.

Figure 17-14: Dogleg Segment. Para 1716.d.
Figure 17-15: Course Change Effect. Para 1717.

Figure 17-16: Application Of Secondary Areas. Para 1717.
Figure 17-17: Cross Section, Secondary Area Obstacle Clearances. Para 1721.

Figure 17-18: Plan View, Secondary Area Obstacle Clearances. Para 1721.
Figure 17-19: Secondary Obstacle Clearance. Para 1722.

Figures 17-20 to 17-22: Reserved

BASE FOR GRAPH

\[ \frac{D_1}{D_2} = \frac{500}{C}, \quad C = \frac{500 \times D_2}{D_1} \]

- \(D_1\): Width of Secondary Area
- \(D_2\): Distance between obstacle and OUTER edge of Secondary Area.

C = Required clearance

Required clearance and distance between obstacle and OUTER edge of Secondary Area.
Example: Enter with MEA of 27,000', Read Allowable Gap 39 NM

Figure 17-23: Allowable Navigation Course Guidance Gaps. Para 1740.
Figure 17-24: LF Segment Primary Obstacle Clearance Area. Para 1750.b.

Figure 17-25: LF Segment Secondary Obstacle Clearance Area. Para 1717.B.
Figure 17-26: LF Segment Obstacle Clearance Within 25 NM Of Enroute Facility. Para 1750.d.

Figure 17-27: LF Segment Obstacle Clearance Area beyond 25 NM From Enroute Facility. Para 1750.d.
Figure 17-28: Minimum Divergence Angle For Radio Fix. Para 1761.b and 1762.b.
Figure 17-29a: Track Using Midpoint Variation. Para 1752.

Figure 17-29b: Track Using Quarterpoint Variation. Para 1752.

Figure 17-29c: Application Of Quarter point Variation For LF/MF to VHF/UHF Facilities. Para 1752.
CHAPTER 18. HOLDING CRITERIA

1800. General
This chapter specifies the criteria for determining the dimensions of airspace to be protected for holding aircraft.

1801. Terminology

a. **Holding Area.** The airspace required at a particular altitude to contain aircraft performing specified entry and holding procedures based on allowances for wind effect, timing errors, fix characteristics, etc.

b. **Holding Pattern.** The race track pattern to be flown by a holding aircraft.

c. **Minimum Holding Altitude (MHA).** The lowest altitude prescribed for a holding pattern, which assures navigational signal coverage, communications, airspace requirements and meets obstacle clearance requirements.

d. **Reduction Area.** For ATC purposes only, that portion of a holding area for which airspace protection may or may not be required, depending upon the direction of entry to the holding pattern, position of the aircraft or length of DME leg used. When assessing a holding pattern for obstacle clearance, the full size of the holding pattern shall be evaluated.

e. **Shuttle Procedure.** A shuttle procedure is a manoeuvre involving a descent or climb in a pattern resembling a holding pattern.

1802. Development Concept
The following factors have been incorporated into the criteria:

a. **Winds.** An analysis of winds at various levels over a 5 year period led to the adoption of a scale of velocities beginning with 50 knots at 4,000 feet ASL and increasing at a rate of 3 knots for each additional 2,000 feet of altitude to a maximum of 120 knots.

b. **Airspeed.** Holding patterns are developed based upon the maximum airspeeds shown in Table 18–1.

c. **Angle of Bank.** The criteria are based upon a bank angle of at least 25° or a rate of turn of 3° per second, whichever requires the lesser bank.

<table>
<thead>
<tr>
<th>A. Propeller Aircraft (including turbo-prop)</th>
<th>175 KT IAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) MHA to 30,000 feet</td>
<td>175 KT IAS</td>
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</tbody>
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<th>B. Civil Turbo-jet</th>
<th>230 KT IAS</th>
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</thead>
<tbody>
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<td>(1) MHA to 14,000 feet</td>
<td>230 KT IAS</td>
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<tr>
<td>(2) Above 14,000 feet</td>
<td>265 KT IAS</td>
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<table>
<thead>
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<th>C. Military Turbo-jet</th>
<th>265 KT IAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) all except those aircraft listed below in 2, 3 and 4</td>
<td>265 KT IAS</td>
</tr>
<tr>
<td>(2) F-4</td>
<td>265 KT IAS</td>
</tr>
<tr>
<td>(3) B-1, F-111 and F-5</td>
<td>310 KT IAS</td>
</tr>
<tr>
<td>(4) T-37 and CT-114</td>
<td>175 KT IAS</td>
</tr>
</tbody>
</table>

*Table 18-1: Maximum Holding Airspeeds. Para 1802.b and 1822.a (1).*
1803. Navigation Aid And Airborne System Tolerance

The criteria in this section apply to conventional navigation aids such as VOR, VOR/DME and/or NDB. Allowances have been made for the following factors:

a. **Cone of ambiguity.** Related to altitude, system error (± 5°) and aircraft track indication (±10° for full instrument deflection). Total tolerance is 15°.

b. **Intersection disparity.** Related to system error and distance between the holding point and the farthest navigation aid used to form it.

c. **Station passage** TO-FROM error: ±4°.

d. **Delay** in recognizing and reacting to fix passage. 6 seconds for entry turn, applied in the direction most significant to protected airspace.

1804. Holding Fixes

Any terminal area fix, except overhead a TACAN, may be used for holding. If that fix is an intersection formed by courses or radials, the following conditions apply:

a. The angle of divergence of the courses or radials shall not be less than 45 degrees. See Figure 18-1.

b. If the facility which provides the crossing course is not an NDB, it may be as much as 45 miles from the point of intersection.

c. If the facility which provides the crossing course is an NDB, it must be within 30 miles of the intersection point.

d. These distances may be exceeded provided the minimum angle of divergence of the intersecting courses is increased at the following rate:

   (1) If an NDB is involved, increase the angle 1 degree for each mile over 30 miles.

   (2) If an NDB is not involved, increase the angle ½ degree for each mile over 45 miles.

![Figure 18-1: Intersections Used For Holding Fixes. Para 1804.a.](image)

1805—1809. Reserved
SECTION 2. HOLDING CRITERIA

1820. Level Holding

There are 31 holding airspace sizes. Each area is related to one or more even-numbered altitudes/flight levels and is identified by a template number for easy reference. See Table 18-2. Templates are drawn to a scale of 1:500,000 (1 inch = approx. 6.9 NM) for use with aeronautical charts having the same scale. Details for tracing templates are contained in Section 3, Para 1831. When use of a different scale is necessary, holding areas may be constructed manually as outlined in Section 3, Para 1832.

a. Alignment. Whenever practical, holding patterns should be aligned to coincide with the flight course to be flown after leaving the holding fix. However, when the flight path to be flown is along an arc, the holding pattern should be aligned on a radial. When a holding pattern is established at a final approach fix and a procedure turn is not used, the inbound course of the holding pattern shall be aligned to coincide with the final approach course unless the final approach fix is a facility. When the final approach fix is a facility, the inbound holding course and the final approach course shall not differ by more than 30 degrees.

![Figure 18-2: Holding Pattern Template Application. Para 1820.b.](image-url)
b. **Area.** Pattern number 4 is normally the minimum size authorized for the primary area. When holding is at an intersection fix, the selected pattern primary area shall be large enough to contain at least 3 corners of the fix displacement area. See Chapter 2, Paras 284 and 285, and Figure 18-2. A secondary area 2 miles wide surrounds the perimeter of the primary area. If using a template smaller than pattern number 4, then the appropriate speed restriction shall be published.

   (1) Altitude. Holding altitudes from 2,000 feet ASL to FL480 are listed. Holding at an even altitude requires the use of the appropriately numbered holding area/template shown opposite the altitude. Holding at odd altitudes above 2,000 feet requires use of the numbered holding area/template for the next higher altitude.

   (2) Template Categories. Table 18–2 shall be used to determine the holding template required. Fix distance is the measured ground distance in nautical miles from the holding fix to the NAVAID. Template sizes are shown for three ranges of fix-to-NAVAID distances: 0-14.9 NM, 15-29.9 NM, and 30 NM and over. Holding overhead a NAVAID requires the use of the 0-14.9 NM group. When a fix is based on information from two navigation aids, the greatest fix-to-NAVAID distance shall be used to determine the correct holding area/template size. This applies to any type or combination of navigation aids used to establish a holding fix.

c. **Obstacle Clearance.** A minimum of 1,000 feet of obstacle clearance shall be provided throughout the primary area. In mountainous regions apply additional obstacle clearance for en route holding. In the secondary area 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge. For computation of obstacle clearance in the secondary area see Annex C, Para 5 and Figure C-3. Allowance for precipitous terrain should be considered as stated in Para 323. Altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet provided the ROC is not violated. See Para 231.

d. **Altitude Selection.** If an approach is made from a properly aligned holding pattern, vice from a procedure turn (see Para 234.e), the holding pattern shall be established over a final or intermediate approach fix and the following conditions shall apply:

   (1) If the holding pattern is established over the final approach fix, the minimum holding altitude shall not be more than 300 feet above the altitude specified for crossing the final approach fix inbound; or

   (2) If the holding pattern is established over the intermediate fix, the minimum holding altitude shall permit descent to the final approach fix altitude within the descent gradient tolerances prescribed for the intermediate segment. See Para 243.d.
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Table 18-2: Holding Area Template Selection Chart. Para 1820, 1821.c, and 1824.
Example:

Altitude: 10,000 feet
Ground Distance: 4.02 NM
Slant Range: 4.4 NM
Geographical Distance

Figure 18-3: DME Slant Range Distance / Cone Of Ambiguity Area Chart. Para 1821.a.
1821. DME Holding

a. Cone of Ambiguity. Cone of ambiguity information is depicted on the DME Slant Range Distance/Cone of Ambiguity Area Chart. See Figure 18-3.

(1) DME fixes shall not be established within the cone of ambiguity above the navigation aid providing DME information.

(2) DME holding may be accomplished either toward or away from a DME navigation aid. When the DME inbound holding track leads toward the navigation aid, the fix end of the holding area, but not the DME fix, may lie within the cone of ambiguity, provided entry to the pattern is normally made from a direction other than through the cone. If entry is usually made through the cone of ambiguity, the entire holding area must lie outside the cone. When the inbound DME holding track leads away from the navigation aid, no part of the holding area may lie within the cone of ambiguity. See Figure 18-4.

Figure 18-4: DME Holding - Cone Of Ambiguity. Para 1821.a.(2).
b. **Effect of Slant Range.** An airborne DME reading of 5 NM at 30,000’ would indicate that an aircraft is directly over the navigation aid. If the aircraft maintained the 5 NM DME distance during descent, its flight path would form an arc beginning over the navigation aid to a point on the surface 5 NM horizontal distance from the navigation aid. Therefore, near the surface a holding fix could be 5 NM horizontally from the navigation aid, but at 13,000’ it would be 4.5 NM horizontally from the navigation aid. In this instance, 5 NM is the fix-to-navigation aid distance, and 4.5 NM is the slant range/geographical distance. See Figure 18-5. When establishing a DME holding fix, the difference between fix-to-navigation aid and slant range/geographical distance shall be determined. DME holding fix distance differences shall be governed by the following:

1. When establishing a DME hold, fix differences between fix-to-navigation aid and slant range/geographical distance shall be determined using the DME Slant Range Distance/Cone of Ambiguity Area Chart. See Figure 18-3.

2. Use whole nautical miles for slant range distance. For example: the minimum DME distance to hold an aircraft at 10,000 feet occurs at a slant-range distance of 2.9 NM. Therefore, holding shall be based on a 3 NM DME fix.

3. When the slant range/geographical distance differs 0.25 NM or less from the fix-to-navigation aid distance at the highest altitude to be used for holding, the difference may be disregarded for altitudes at or below 14,000 feet. A difference of 0.5 NM or less may be disregarded above 14,000 feet.

Example: A DME fix is required for holding at and below 10,000 feet at a geographical distance of 8 NM. Figure 18-3 shows that the 8 NM slant range at 10,000 feet is 7.84 NM horizontally from the navigation aid. The difference of 0.16NM may be disregarded when plotting protected airspace. If the holding altitude in the same example is changed to FL200, the horizontal distance at FL200 would be 7.3 NM, creating a difference of 0.7 NM. In this case, protected airspace should be based on a distance of 7.3 NM.

4. Collocation of DME and Non-DME fixes. When a DME holding fix is to be collocated with another established fix, and the horizontal distance between the established fix and the navigation aid providing DME information is to be used as the DME slant range distance, significant distance differences may exist. Differences shall be governed by the following:

   a) When it is desirable to use a single distance with respect to both DME and VOR intersection holding, plot the holding area based on the VOR intersection. Then replot the slant range/geographical distance from the navigation aid for the highest holding altitude. The combined perimeter of the two plots determines the airspace to be protected.

   b) When it is desirable to contain DME and non-DME holding within a single pattern size, use a slant range distance different from the distance between the non-DME fix and the navigation aid providing DME information. Select a slant range distance, for the highest altitude to be used for holding, which is coincident with the distance between the non-DME fix and the navigation aid providing DME information. See Figure 18-6.
Figure 18-5: Slant Range/Geographical Distance. Para 1821.b.

Figure 18-6: Collocated Fix (Single Holding Area). Para 1821.b.(4)(b).
1822. Shuttle Procedures

A shuttle procedure is a manoeuvre involving a descent or climb in a pattern resembling a holding pattern. Shuttles are generally used on procedures located in mountainous areas. In the approach phase, it is normally prescribed where a descent of more than 2,000 feet is required during the initial or intermediate approach segments. In may also be required when flying a missed approach or departure procedure from certain aerodromes.

a. Shuttle Climb.

(1) Area. When a shuttle climb is used, the primary holding area shall encompass the departure or missed approach segment width at the holding fix. See Figure 18-7. A secondary area 2 miles wide surrounds the perimeter of the primary area.

The holding area/speed relationship in Table 18–1 is not adequate for climbing aircraft primarily because climb speeds exceed level holding speeds. Shuttle climb areas may be assessed using the following templates:

(a) If using the 200 KT or 210 KT template, publish a speed restriction of 175 KIAS.
(b) If using the 230 KT template, publish a speed restriction of 200 KIAS.
(c) If using the 265 KT template, publish a speed restriction of 250 KIAS.
(d) If using the 310 KT holding pattern, no speed restriction is required.

Example: A departing turbo-jet aircraft must shuttle climb to 16,000 feet at an NDB. Table 18–2 (310 KT at 16,000 feet) indicates template number 19 will provide the necessary protected airspace.

(e) When developing a shuttle climb, it is acceptable to begin obstacle assessment using the smallest template appropriate for the altitude that the shuttle starts and increase the template size appropriate for altitude as the aircraft climbs and true airspeed increases.

Example: A departure, within mountainous terrain, requires the aircraft to shuttle climb to 16,000 feet before proceeding on course. The field elevation is 2,600 feet. The holding facility is within 5 NM of the departure aerodrome. The speed in the climb will be restricted to 200 KIAS.

Start the obstacle assessment using template number 6, which is appropriate for 4,000 feet and 230 KIAS. Then reassess the procedure using the templates appropriate for 6,000 feet, 8,000 feet, 10,000 feet, 12,000 feet, 14,000 feet and finally 16,000 feet. As the aircraft climbs, the size of the holding area will increase to accommodate the increase in aircraft true airspeed.

(2) Obstacle Clearance. When a shuttle climb is used, as in a departure or missed approach, no obstacle shall penetrate the holding surface. This surface begins at the end of the segment leading to the holding fix. Its elevation is that of the departure OIS or missed approach surface at the holding fix. It rises at a 40:1 rate to the edge of the primary area, then at a 12:1 rate to the outer edge of the secondary area. The distance to any obstacle is measured from the obstacle to the nearest point on the end of the segment at the holding fix. See Figure 18-7.
b. Shuttle Descent.

(1) Alignment. When a holding pattern is established at a final approach fix and a procedure turn is not used, the inbound course of the holding pattern shall be aligned to coincide with the final approach course unless the final approach fix is a facility. When the final approach fix is a facility, the inbound holding course and the final approach course shall not differ by more than 30 degrees.

(2) Area. Shuttle descent areas may be assessed using the following templates:

(a) If using the 200 KT or 210 KT template, publish a speed restriction of 175 KIAS.
(b) If using the 230 KT template, publish a speed restriction of 200 KIAS.
(c) If using the 265 KT template, publish a speed restriction of 250 KIAS.
(d) When assessing a shuttle descent, it is acceptable to reduce the template size appropriate for altitude as the aircraft descends, similar to the shuttle climb.

(3) Obstacle Clearance. A minimum of 1,000 feet of obstacle clearance shall be provided throughout the primary area. In the secondary area 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge.

Figure 18-7: Climbing In A Holding Pattern. Para 1822.a.(2).
1823. Holding Patterns On ILS Courses

Holding patterns shall not be established inbound on an ILS localizer between the FAF and the localizer antenna below 5,000 feet above the antenna elevation, in order to avoid creating unwanted reflected signals. Holding patterns opposite to the inbound course are acceptable. See Figure 18-8. Ensure localizer signal coverage when establishing the hold.

1824. GPS Holding

The airspace to be protected for GPS holding is the same as per the template areas in Table 18–2. When holding is at a GPS waypoint the primary area of the selected pattern shall be large enough to contain the entire waypoint displacement area (see Table 16–1). Use the 15 NM distance for terminal holding procedures and 30 NM distance for en route holding.

1825—1829. RESERVED

Figure 18-8: Reflected Signal Area. Para 1823.
SECTION 3. CONSTRUCTION OF HOLDING AREAS

1830. Reserved

1831. Tracing Of Templates

a. Primary Area. The perimeter of the template contains four radii and two straight lines. Position the holding fix grommet hole over the fix, and align the solid black line with the inbound holding track. Trace the pattern perimeter. See Figure 18-9.

(1) Right Turn Pattern. The numbers on the template should be face-up and readable.

(2) Left Turn Pattern. The numbers on the template should be face-down.

b. Secondary Area. Manually draw the secondary area 2 miles from the edge of the primary area.

![Figure 18-9: Holding Template. Para 1831.a.](image)
1832. Manual Construction Of Holding Areas

Each holding area may be manually constructed by applying the dimensions for the area concerned, as provided in Table 18–3 and using the reference points depicted in Figure 18-10, and in accordance with the following directions:

   a. Locate and mark the holding fix with the letter L.
   b. Draw the inbound track; A to L, L to M, and M to G.
   c. At a 90° angle from the inbound track locate and mark Points B above A, F above G, E above M, H below M and I below L.
   d. Connect I and H with a straight line.
   e. Set the compass for distance L-B; place the compass center at L and draw an arc from B to beyond C. (Note: C is a general location above L.)
   f. Draw a straight line from E tangent to the arc B-C.
   g. Set the compass for distance L-B; place the compass center at B and draw a short arc above L; relocate the compass center at I and draw a short arc through the first arc; relocate the compass center at the intersection of the arcs and connect I-B.
   h. Set the compass for distance F-M; Place the compass center at F, draw an arc from above H to below E. Place the compass center at E and draw a short arc below M. Place the compass center at H and draw a short arc above M. The arcs formed from E and H intersect the arc formed from F. Place the compass center at the appropriate intersection of these arcs and connect E-F; place the compass center at the other intersection and connect F-H.

![Figure 18-10: Construction Code For Basic Area. Para 1832.](image)

1833—1899. Reserved
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