TERPS vs PANS-Ops
Procedure Design and Operational Differences
Monday, March 17, 2014 | 10:30 a.m. – 12:00 p.m.

PRESENTED BY:
Guy Gribble
General Manager, International Flight Resources
TERPS vs PANS-Ops

They Are The Same, Only Different

Physics, Aerodynamics, Mathematics

Units of Measure

US Customary Units vs. Meters

Conversions?

Rounding of Numbers

Fix Tolerances and Accuracy

Flight Technical Errors
Who is In Charge Here?

- State (Country)
  Aeronautical Information Publication, AIP
  Flight Check, Maintain
  Publish, Revise

- Design Criteria
  Standard design development
  Role of the Procedure Designer
  Pilot operational procedures

- ICAO, International Civil Aviation Organization
  SARPS vs. Documents
Where Does This Data Come From?

State (Country)
Commercial Provider
WGS-84 Compliant?
Airport
Country
Somewhere?
TERPS vs PANS-Ops

Standard Instrument Departure

- “Normal” Operations
- Maintain the Ground Track
- Maintain the Required Climb Gradient

1.7 ABNORMAL AND EMERGENCY OPERATIONS

1.7.1 The design of procedures in accordance with this section assumes normal operations and that all engines are operating.

1.7.2 It is the responsibility of the operator to conduct an examination of all relevant obstacles and to ensure that the performance requirements of Annex 6 are met by the provision of contingency procedures for abnormal and emergency operations. Where terrain and/or obstacle considerations permit, the contingency procedure routing should follow that of the departure procedure.

1.7.3 It is the responsibility of the State to make available the obstacle information described in Annexes 4 and 6, and any additional information used in the design of departures in accordance with this Section.
Standard Instrument Departure
Vertically Speaking

Departure End Of Runway
DER

35 Ft? 15? 5 M
TERPS vs PANS-Ops

Standard Instrument Departure
If straight out will not work...

- Climb faster over obstacle
- Turn away from obstacle
- Keep in sight, “See and avoid”
- Climb in a safe sector away from obstacle
- Speed limiting
- Combinations of any of the above
TERPS vs PANS-Ops

Standard Instrument Departure
Climb Faster Over Obstacle

Requires 350'/NM Until Reaching MSA

Maintain 4.3% Until Reaching 1700MSL
Standard Instrument Departure

Turn Away From Obstacle

Approximately 2 NM

Initial Climb Area

Approximately 3.5 KM

Area 1

15° Splay

TERPS vs PANS-OPS

NBAA
TERPS vs PANS-Ops

Standard Instrument Departure
Turn Away From Obstacle

≈ 2 NM

≈ 3.5 KM

Initial Climb Area

15° Splay

Area 1
TERPS vs PANS-Ops

Standard Instrument Departure, TERPS

Keep in Sight and Tell Pilot to "See and Avoid"

Visual Climb Over Airport

Hazard Beacons on top of hill to the east clearly visible or Take Off Minimums 600/1

15° MAX
TERPS vs PANS-Ops

Standard Instrument Departure, TERPS
Climb in a Safe Sector

Diverse Departure Evaluation

No Departure Turns East

15° MAX

25 or 46 NM
TERPS vs PANS-Ops

Standard Instrument Departure, PANS-Ops

Climb in a Safe Sector
TERPS vs PANS-Ops

Standard Instrument Departure, PANS-Ops

Climb in a Safe Sector
TERPS vs PANS-Ops

Standard Instrument Departure
Vertically Speaking

LSZH/ZRH
ZURICH

24 FEB 12 10-3B Eff 8 Mar

ZURICH Departure 125.95
Apt Elev 1417'

Trans level: By ATC  Trans alt: 7000'
1. When instructed contact ZURICH Departure.
2. RWY 16 - VISUAL CONDITIONS FOR TAKE-OFF:
   Ceiling 1500' - VIS 5000m.  3. SIDs are also noise
   abatement procedures. Strict adherence within the
   limits of aircraft performance is mandatory.
4. EXPECT close-in obstacles.

ALBIX 1C [ALBI1C]
ALBIX 1D [ALBI1D]
ALBIX 1R [ALBI1R]
RWYS 10, 16 DEPARTURES

SPEED: MAX 250 KT BELOW FL100

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**TERPS vs PANS-Ops**

Standard Instrument Departure

“Minimum Safe Altitude”, MSA TERPS

<table>
<thead>
<tr>
<th>MRLB/LIR</th>
<th>LIBERIA, COSTA RICA</th>
<th>7 OCT 05</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANIEL ODuber Quiros INTL</td>
<td>VOR Rwy 07</td>
<td>13-2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BRIEFING STRIP</th>
<th>*LIBERIA Approach</th>
<th>*LIBERIA Tower</th>
<th>*Ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>119.8</td>
<td>118.8</td>
<td>121.7</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VOR LIB</th>
<th>Final Apch Crs</th>
<th>Minimum Alt</th>
<th>MDA(H)</th>
<th>Apt Elev</th>
<th>TDZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>112.8</td>
<td>065°</td>
<td>D10.0 3000’ (2742’)</td>
<td>1580’ (1322’)</td>
<td>269’</td>
<td>258’</td>
</tr>
</tbody>
</table>

**MISSED APCH:** Climb outbound on LIB VOR R-065 to D4.0, then turn RIGHT and return to LIB VOR at or above 3000’. Join holding pattern or continue outbound on LIB VOR R-265 to initiate another approach.

Alt Set: hPa | TDZ Elev: 9 hPa | Trans level: FL 200 | Trans alt: 19000’
---|---|---|---

Buffer?

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**TERPS vs PANS-Ops**

Standard Instrument Departure

“Minimum Sector Altitude”, MSA PANS-Ops

<table>
<thead>
<tr>
<th>MRLB/LIR</th>
<th>LIBERIA, COSTA RICA VOR Rwy 07</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANIEL ODUBER QUIROS INTL</td>
<td>7 OCT 05 13-2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>*LIBERIA Approach</th>
<th>*LIBERIA Tower</th>
<th>*Ground</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VOR LIB</strong></td>
<td>119.8</td>
<td>118.8</td>
<td>121.7</td>
</tr>
<tr>
<td><strong>Final Apch Crs</strong></td>
<td><strong>065°</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minimum Alt</strong></td>
<td><strong>D10.0</strong></td>
<td><strong>3000’ (2742’)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>MDA(H)</strong></td>
<td><strong>1580’ (1322’)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Apt Elev</strong></td>
<td><strong>269’</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TDZE</strong></td>
<td><strong>258’</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Alt Set: hPa</strong></td>
<td><strong>TDZ Elev: 9 hPa</strong></td>
<td>Trans level: FL 200</td>
<td>Trans alt: 19000’</td>
</tr>
</tbody>
</table>

**MISSED APCH:** Climb outbound on LIB VOR R-065 to D4.0, then turn RIGHT and return to LIB VOR at or above 3000’. Join holding pattern or continue outbound on LIB VOR R-265 to initiate another approach.

**Buffer?**

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TERPS vs PANS-Ops

Standard Instrument Departure

“Minimum Safe Altitude”, MSA  Country Specific

“Emergency Safe Altitude”
TERPS vs PANS-Ops

Holding
Timing

PANS-Ops

>14,000 = 1.5 Minute
≤ 14,000 = 1 Minute

TERPS
**TERPS vs PANS-Ops**

**Holding Speeds**

- **PANS-Ops**
  - $>34,000 = IMN.83$
  - $>20,000 \leq 34,000 = 265 \text{ KIAS}$
  - $>14,000 \leq 20,000 = 240 \text{ KIAS}$
  - $\leq 14,000 = 230 \text{ KIAS} >14,000 = 240$ $265$
  - $>6,000 \leq 14,000 = 220 \text{ KIAS}$ $230/210 \text{ KIAS}$
  - $\leq 6,000 = 210$ $200 \text{ KIAS}$

- **TERPS**
TERPS vs PANS-Ops

Holding
Evaluated Airspace
### Terps vs PANS-Ops

#### Arrivals and Maneuvering Procedures

<table>
<thead>
<tr>
<th>TERPS</th>
<th>PANS-Ops</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
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<tr>
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<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

- Definitions and Use of Entry Procedures
- Evaluated Airspace
- Obstacle Clearance
- Speeds
- Selection of Turn
- Tracking Requirements
TERPS vs PANS-Ops

Arrivals and Maneuvering Procedures

45/180
80/260
Teardrop
10 NM Limit
Holding
In lieu of

45/180
80/260
Base Turn
Turn point
Entry Sector
Racetrack
TERPS vs PANS-Ops

Arrivals and Maneuvering Procedures, TERPS

Entry Zone
TERPS vs PANS-Ops

Arrivals and Maneuvering Procedures, PANS-Ops

Entry Sector Defined
TERPS vs PANS-Ops

Arrivals and Maneuvering Procedures, PANS-Ops

Omni-Directional Defined
TERPS vs PANS-Ops

Evaluated Airspace Intermediate Segment, TERPS
TERPS vs PANS-Ops

Evaluated Airspace Intermediate Segment, PANS-Ops
3. When the approach procedure involves a procedure turn, a maximum speed of not greater than 200 knots (IAS) should be observed from first overheading the course reversal IAF through the procedure turn maneuver to ensure containment within the obstruction clearance area. Pilots should begin the outbound turn immediately after passing the procedure turn fix. The procedure turn maneuver must be executed within the distance specified in the profile view. The normal procedure turn distance is 10 miles. This may be reduced to a minimum of 5 miles where only Category A or helicopter aircraft are to be operated or increased to as much as 15 miles to accommodate high performance aircraft.
### TERPS vs PANS-Ops

**Arrivals and Maneuvering Procedures, Speeds**

Table I-4-1-2. Speeds (IAS) for procedure calculations in knots (kt)

<table>
<thead>
<tr>
<th>Aircraft category</th>
<th>$V_{at}$</th>
<th>Range of speeds for initial approach</th>
<th>Range of final approach speeds</th>
<th>Max speeds for visual manoeuvring (circling)</th>
<th>Max speeds for missed approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt;91</td>
<td>90/150 (110*)</td>
<td>70/100</td>
<td>100</td>
<td>100 (Intermediate) 110 (Final)</td>
</tr>
<tr>
<td>B</td>
<td>91/120</td>
<td>120/180 (140*)</td>
<td>85/130</td>
<td>135</td>
<td>130 (Intermediate) 150 (Final)</td>
</tr>
<tr>
<td>C</td>
<td>121/140</td>
<td><strong>160/240</strong></td>
<td>115/160</td>
<td>180</td>
<td>160 (Intermediate) 240 (Final)</td>
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<tr>
<td>D</td>
<td>141/165</td>
<td><strong>185/250</strong></td>
<td>130/185</td>
<td>205</td>
<td>185 (Intermediate) 265 (Final)</td>
</tr>
<tr>
<td>E</td>
<td>166/210</td>
<td>185/250</td>
<td>155/230</td>
<td>240</td>
<td>230 (Intermediate) 275 (Final)</td>
</tr>
</tbody>
</table>
TERPS vs PANS-Ops

Procedure Course Tracking, @ End of Final Approach

+/- 5° NDB +/- 5°
1/2 Scale VOR 1/2 Scale
1/2 Scale ILS 1/2 Scale
3/4 Scale GPS 1/2 Scale
2/3 Scale LPV/APV 1/2 Scale
<table>
<thead>
<tr>
<th>Terrestrial</th>
<th>Precision</th>
<th>TERPS</th>
<th>Non-Precision</th>
<th>&quot;2 D&quot;</th>
<th>&quot;Non-Precision&quot; &quot;2 D&quot;</th>
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<tbody>
<tr>
<td></td>
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<td>MDA (H)</td>
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<tr>
<td>LOC</td>
<td>LOC</td>
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<td>VOR</td>
<td>VOR</td>
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<td>NDB</td>
<td>NDB</td>
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<tr>
<td>LP</td>
<td>LP</td>
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<td></td>
</tr>
<tr>
<td>RNAV (RNP)</td>
<td>APCH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNAV (GPS)</td>
<td>GNSS</td>
<td></td>
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</tr>
<tr>
<td>Rwy/App</td>
<td>Rwy/App</td>
<td></td>
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<tr>
<td>&gt;450'/1SM</td>
<td>Rwy/App</td>
<td></td>
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<td></td>
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<tr>
<td>Parallel Taxi</td>
<td>Rwy/App</td>
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<table>
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<th>&quot;3 D&quot;</th>
<th>&quot;3 D&quot;</th>
<th>&quot;3 D&quot;</th>
<th>&quot;3 D&quot;</th>
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</thead>
<tbody>
<tr>
<td>RNP APCH</td>
<td>DA</td>
<td>DA</td>
<td>DA (H)</td>
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<tr>
<td>RNP-AR</td>
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</tr>
<tr>
<td>RNAV (RNP)</td>
<td>APCH</td>
<td>&quot;LPV&quot;</td>
<td>&quot;RNP 0.30&quot;</td>
<td></td>
</tr>
<tr>
<td>RNAV (GPS)</td>
<td>GNSS</td>
<td>Rwy/App</td>
<td>Rwy/App</td>
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<td>Rwy/App Lts</td>
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</table>

<table>
<thead>
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<th>Precision</th>
<th>Precision</th>
<th>Precision</th>
<th>Precision</th>
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</thead>
<tbody>
<tr>
<td>MLS, ILS</td>
<td>MLS, ILS</td>
<td>DGPS</td>
<td>Rwy/App</td>
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<tr>
<td>GLS</td>
<td>Rwy/App</td>
<td></td>
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</tr>
<tr>
<td>Rwy/App</td>
<td></td>
<td></td>
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</tbody>
</table>
TERPS vs PANS-Ops

Evaluated Airspace Final Segment, Non-Precision/2D

VOR = 7.8° SPLAY
NDB = 10.3° SPLAY
VOR/NDB = 14.29° SPLAY
TERPS vs PANS-Ops

Evaluated Airspace Final Segment, Non-Precision/2D

LNAV

2 NM

FAF

VOR = 7.8° SPLAY
NDB = 10.3° SPLAY
VOR/NDB = 14.29° SPLAY

LNAV = RNP X 2/RNP X 2
LP = Taper/Taper
TERPS vs PANS-Ops

Approach Procedures, MDA (H)

- 350 No Final Approach Fix
- 300 W/ Final Approach Fix
- 250 LP/RNP APCH/LNAV

Assumed lowest flight path
Non-Precision Approach Stats

60% of CFIT accidents occur on NP approaches
✓ 47% occurred during step-down NP approaches
✓ Almost all accidents occurred in darkness or IMC
✓ 48% in mostly flat terrain
✓ Most common cause: descent below MDA

NTSB, FSF
TERPS vs PANS-Ops

NPA Approach and RNP Compared

LOC, VOR, NDB

Definition of Use for Evaluated Airspace OCA/ROC Speeds Visual Aids and Cues

LNAV/VNAV RNAV (RNP)/(GNSS)

LNAV Using "CDFA", LNAV/VNAV
TERPS vs PANS-Ops

ILS Approach and RNP Compared

<table>
<thead>
<tr>
<th>ILS/ILS</th>
<th>LPV/APV</th>
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</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
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<tr>
<td>X</td>
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</table>

Definition of
Use for
Evaluated Airspace
OCA/ROC
Speeds
Visual Aids and Cues

LP or LPV/APV
ILS Approach and RNP Compared, "RNP-AR"

<table>
<thead>
<tr>
<th>SEGMENT</th>
<th>MAXIMUM</th>
<th>STANDARD</th>
<th>MINIMUM</th>
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<tbody>
<tr>
<td>Feeder</td>
<td>2</td>
<td>2</td>
<td>1.0</td>
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<tr>
<td>Initial</td>
<td>1</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Intermediate</td>
<td>1</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Final</td>
<td>0.5</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Missed Approach</td>
<td>1</td>
<td>1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

TERPS vs PANS-Ops

ILS/ILS

LP or LPV/APV

LPV/APV

RF Leg
TERPS vs. PANS-Ops

Visual Approaches vs. Visual w/ Ground Track
TERPS vs PANS-Ops

IAP Approach Protected Airspace

Visual Approach Protected Airspace?
TERPS vs PANS-Ops

Visual Approach Protected Airspace

TERPS, "Standard Visual Area" (Circling or IAP)

MDA/VDP
300'/NM 20:1 or 5000/1sm req
1.65 NM
1 NM
Thld

PANS-Ops,"Visual Segment Surface" NPA/2D, Wingspan>118'

OCA(H)
GPA - 1.12°
1.65 NM
1 NM
Thld

196'
TERPS vs PANS-Ops

Visual Approach Protected Airspace

TERPS, "Standard Visual Area" (Circling or IAP)

MDA/VDP
300'/NM 20:1 or 5000/1sm req

/+ - 15°

MDA/VDP
1.65 NM 1 NM Thld

/+ - 400'
/+ - 1,780'
/+ - 1,200'

PANS-Ops, "Visual Segment Surface" PA/3D, Wingspan>118'

OCA(H)

GPA – 1.12°

/+ - 196'
/+ - 295'
/+ - 295'

/+ - 295'
1.65 NM 1 NM Thld
"Visual" vs. Circle-to-Land / Visual Maneuvering

Definition of Use for Evaluated Airspace OCA/ROC Speeds Visual Aids and Cues MDA vs. Descent Point
TERPS vs PANS-Ops

Circling Approaches and Visual Maneuvering

“C” 2.68 NM
“D” 3.49 NM
1.7 NM
2.3 NM

“C” 4.2 NM
“D” 5.28 NM
## TERPS vs PANS-Ops

### Circling Approaches and Visual Maneuvering

#### Pans-Ops

<table>
<thead>
<tr>
<th>Acft Cat</th>
<th>Min Vis</th>
<th>MOC/HAA</th>
<th>Max Spd/°AOB</th>
<th>2xR + Straight</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>2.0 NM</td>
<td>394/ 591 ft</td>
<td>180 KIAS/20°</td>
<td>3.70+.5 = 4.20 NM</td>
</tr>
<tr>
<td>D</td>
<td>2.5 NM</td>
<td>394/ 689 ft</td>
<td>205 KIAS/20°</td>
<td>4.68+.6 = 5.28 NM</td>
</tr>
</tbody>
</table>

#### TERPS

<table>
<thead>
<tr>
<th>OEA Radius +</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acft Cat</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
</tbody>
</table>

*With Change #21 and later, At 2000’MSL, ISA Standard and 25KTS of added wind. Visibility in Statue Miles*  

**OEA= Obstacle Evaluated Area, CAR= Circling Area Radius (1.3NM Minimum)**
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### Flight Procedures

#### Holding

**Maximum Speeds**

- a. Propeller-driven aircraft to 14,000’ – 170 KIAS
- b. Propeller-driven aircraft above 14,000’ – 175 KIAS
- c. Turbo-Jet aircraft to 6000’ – 200 KIAS
- d. Turbo-Jet above 6000’ to 14,000’ – 210 KIAS
- e. Turbo-Jet above 14,000’ – 230 KIAS

In general, holding pattern circuits are limited to one minute outbound.

#### Procedure Limitations and Options

Instrument approach procedures are based on those contained in PANS-OPS Document 8168.

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#### Measurement of Unit

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance used in navigation, position reporting, etc. (Generally more than 2 NM)</td>
<td>Nautical Miles and tenths of NM</td>
</tr>
<tr>
<td>Relatively short distances such as those relating to airport (e.g., runway lengths)</td>
<td>Meters/Feet</td>
</tr>
<tr>
<td>Altitudes, elevations and heights</td>
<td>Meters/Feet</td>
</tr>
<tr>
<td>Vertical speed</td>
<td>Feet Per Minute</td>
</tr>
<tr>
<td>Wind direction for landing and taking off</td>
<td>Degrees Magnetic</td>
</tr>
<tr>
<td>Visibility, including runway visual range</td>
<td>Statute Miles / Meters</td>
</tr>
<tr>
<td>Altimeter setting</td>
<td>Hectopascals, Millibars or Inches of Mercury</td>
</tr>
<tr>
<td>Temperature</td>
<td>Degrees Celsius (Centigrade)</td>
</tr>
<tr>
<td>Weight</td>
<td>Metric Tons / Kilograms / Pounds</td>
</tr>
<tr>
<td>Time</td>
<td>Hours and Minutes, the day of 24 hours beginning at midnight UTC</td>
</tr>
</tbody>
</table>

#### Approach Category

<table>
<thead>
<tr>
<th>Approach Category</th>
<th>Radius (Nautical Miles)</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>1.3</td>
</tr>
<tr>
<td>B</td>
<td>1.5</td>
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<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>

A minimum obstacle clearance of 300° is provided within the circling approach area.

#### Aircraft Speed Restrictions

Maximum speed 250 KIAS:

- a. Aircraft operating under VFR;
- b. Aircraft operating under IFR:
  1. below 10,000’ in the national airspace;
  2. within 30 NM from any airport at or below 10,000’ AGL of the airport elevation.

Maximum speed 200 KIAS:

- Aircraft operating under IFR within 10 NM of an aerodrome when below 3000’ AGL above that aerodrome elevation.

Aircraft operating under IFR shall not exceed those speeds established for descent, climb and holding procedures.

When Radar Control is provided, adjusted speeds will not exceed those stipulated by ATC.

#### Airport Operating Minimums

Mexico publishes DH(HAT), MDA(HAT) or HAA and visibility for landing. Ceiling and visibility are published for take-off and alternate.

Jeppesen charted minimums are not below State Minimums.
Intermediate Missed Approach

Missed Approach Procedures, TERPS

TERPS vs PANS-Ops

Nominal descent path
Nominal MAPt

Final approach segment
Final missed approach

Intermediate Missed Approach
Intermediate missed approach

30 m (98 ft)
50 m (164 ft)

OCA/H

2.5%
2.5%
Missed Approach Procedures, PANS-Ops