Introduction to Airport Engineering

Preston Rufe, PE
T-O Engineers
Overview

• Three (3) types of airports criteria:
  1. FAR Part 77 – Objects Affecting Navigable Airspace
  2. FAA AC 150/5300-13 – Airport Design
  3. FAA Order 8260.3B, The United States Standard for Terminal Instrument Procedures (TERPS)

• Unfortunately, not all three agree, all the time

• Let’s take a look at each component
FAR Part 77 Airspace

• Federal Aviation Regulations Part 77
• This part establishes:
  a) The requirements to provide notice to the FAA of certain proposed construction, or the alteration of existing structures;
  b) The standards used to determine obstructions to air navigation, and navigational and communication facilities;
  c) The process for aeronautical studies of obstructions to air navigation or navigational facilities to determine the effect on the safe and efficient use of navigable airspace, air navigation facilities or equipment; and
  d) The process to petition the FAA for discretionary review of determinations, revisions, and extensions of determinations.
FAR Part 77 Airspace

- FAA review under Part 77 results in:
  - No Objection, or
  - Objection with Mitigation, or
  - Objection
Part 77 Surfaces, Plan View
Part 77 Surfaces, 3-D View

Source: http://www.ngs.noaa.gov/AERO/3dfar77.html
## OBSTRUCTION IDENTIFICATION SURFACES
Federal Aviation Regulations Part 77

<table>
<thead>
<tr>
<th>DIM</th>
<th>ITEM</th>
<th>VISUAL RUNWAY</th>
<th>NON - PRECISION INSTRUMENT RUNWAY</th>
<th>PRECISION INSTRUMENT RUNWAY PIR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>WIDTH OF PRIMARY SURFACE AND APPROACH SURFACE WIDTH AT INNER END</td>
<td>250</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>B</td>
<td>RADIUS OF HORIZONTAL SURFACE</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>C</td>
<td>APPROACH SURFACE WIDTH AT END</td>
<td>1,250</td>
<td>1,500</td>
<td>2,000</td>
</tr>
<tr>
<td>D</td>
<td>APPROACH SURFACE LENGTH</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>E</td>
<td>APPROACH SLOPE</td>
<td>20:1</td>
<td>20:1</td>
<td>20:1</td>
</tr>
</tbody>
</table>

- A - UTILITY RUNWAYS
- B - RUNWAYS LARGER THAN UTILITY
- C - VISIBILITY MINIMUMS GREATER THAN 3/4 MILE
- D - VISIBILITY MINIMUMS AS LOW AS 3/4 MILE
- * - PRECISION INSTRUMENT APPROACH SLOPE IS 50:1 FOR INNER 10,000 FEET AND 40:1 FOR AN ADDITIONAL 40,000 FEET

Source: [http://www.ngs.noaa.gov/AERO/oisspec.html](http://www.ngs.noaa.gov/AERO/oisspec.html)
An Example of Part 77 Surfaces

• **Airport/Facility Directory**

SHOSHONE CO  (S83)  3 W  UTC–8(–7DT)  N47°32.84’ W116°11.34’
2227  B  S3  FUEL  100LL  TPA—3227(1000)  NOTAM FILE BOI
RWY 07–25: H5316X75 (ASPH)  S–14  MIRL  0.4% up E
RWY 07: Tree. Rgt tfc.
RWY 25: Thld dsplcd 335’. Tree.
AIRPORT REMARKS: Attended dalglt hrs. ACTIVATE MIRL Rwy 07–25—CTAF.
AIRPORT MANAGER: 208-786-5381
COMMUNICATIONS: CTAF/UNICOM 122.8
RADIO AIDS TO NAVIGATION: NOTAM FILE MLP
MULLAN PASS (H) VOR/DME 117.8  MLP  Chan 125  N47°27.41’
W115°38.76’  269° 22.7 NM to fld. 6100/15E. HIWAS.
VOR portion unusable:
060°–090° byd 20 NM blo 9,500’
An Example of Part 77 Surfaces
AC 150/5300-13A Airport Design

- Runway
- Taxiway
- Aprons
- Terminal

Source: T-O Engineers
Design Process

- FAA Advisory Circulars
  - [http://www.faa.gov/airports/engineering/design_standards/](http://www.faa.gov/airports/engineering/design_standards/)
    - Airport Design – 150/5300-13A
  - Determine Design Aircraft

- Runway Design Code (RDC)

<table>
<thead>
<tr>
<th>Aircraft Approach Category (AAC)</th>
<th>Approach Speed (kts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>&lt;91</td>
</tr>
<tr>
<td>B</td>
<td>91 - &lt;121</td>
</tr>
<tr>
<td>C</td>
<td>121 - &lt;141</td>
</tr>
<tr>
<td>D</td>
<td>141 - &lt;166</td>
</tr>
<tr>
<td>E</td>
<td>166 or more</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Airplane Design Group (ADG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group #</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>II</td>
</tr>
<tr>
<td>III</td>
</tr>
<tr>
<td>IV</td>
</tr>
<tr>
<td>V</td>
</tr>
<tr>
<td>VI</td>
</tr>
</tbody>
</table>

Source: AC 150/5300-13A
Design Process

• Runway Design Code (RDC) (con’t)

<table>
<thead>
<tr>
<th>RVR (ft)</th>
<th>Visibility Minimums</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>&gt;= 1</td>
</tr>
<tr>
<td>4000</td>
<td>¾ – &lt;1</td>
</tr>
<tr>
<td>2400</td>
<td>½ – &lt;¾</td>
</tr>
<tr>
<td>1600</td>
<td>¼ – &lt;½</td>
</tr>
<tr>
<td>1200</td>
<td>&lt;¼</td>
</tr>
</tbody>
</table>

○ Example RDC: B-II-2400

Source: AC 150/5300-13A
Design Process

- Basically, aircraft characteristics and design components drive design

<table>
<thead>
<tr>
<th>Aircraft Characteristics</th>
<th>Design Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach Speed</td>
<td>RSA, ROFA, RPZ, runway width, runway-to-taxiway separation, runway-to-fixed object.</td>
</tr>
<tr>
<td>Landing and Takeoff Distance</td>
<td>Runway length</td>
</tr>
<tr>
<td>Cockpit to Main Gear Distance (CMG)</td>
<td>Fillet design, apron area, parking layout</td>
</tr>
<tr>
<td>Main Gear Width (MGW)</td>
<td>Taxiway width, fillet design</td>
</tr>
<tr>
<td>Wingspan / Tail Height</td>
<td>Taxiway and apron OFA, parking configuration, hangar locations, taxiway-to-taxiway separation, runway to taxiway separation</td>
</tr>
</tbody>
</table>

- “Instrument flight procedures minimums are based on the characteristics and infrastructure of the runway (i.e., markings, approach light system, protected airspace, etc.), airspace evaluation, and the navigation system available to the aircraft. Unless these items are considered in the development of the airport, the operational minimums may be other than desired.”
  (AC 150/5300-13A, 201.(a.))

Source: AC 150/5300-13A
Runway Design

• Basic Considerations
  • Length
    o Aircraft Performance
    o Elevation
    o Temperature
  • Width - Aircraft Size
  • Orientation - Wind Coverage

Source: FAA Advisory Circular 5325-4
Wind Rose

- Orient runway to achieve 95% Wind Coverage
- Allowable crosswind component determined by RDC (10.5 kts to 20 kts)

https://airports-gis.faa.gov/airportsgis/publicToolbox/windroseForm.jsp

Source: T-O Engineers
Airfield Separations

- Runway to Runway
- Runway to Taxiway
- Runway to Aircraft Parking
- Taxiway to Taxiway

Function of
- Aircraft Size
- Visibility Minimums

Source: T-O Engineers
Taxiway Design

- Separation
- Width - Aircraft Size
- Intersection - Gear Layout
- Additional Considerations

Source: T-O Engineers
Apron Design

• Function
  • General Aviation versus Commercial

• Aircraft Size
  • Length
  • Wingspan

Source: T-O Engineers
Surface Gradients

- Pavement and Safety Areas
  - Longitudinal
  - Transverse
  - Vertical Curves

- Surface
  - PFC
  - Grooving

Source: FAA Advisory Circular 5300-13
Pavement Section Design

• Layered Elastic Design
  o FAAFIELD

• Considerations
  o Fleet Mix
  o Operations
  o Aircraft Weight
  o Gear Configuration
    ▪ Single, Dual, Dual Tandem, Double Dual Tandem
  o Frost Protection
Additional Airfield Components

• Electrical
  o Lights
  o Signs
  o NAVAIDS

• Markings

• Drainage

Source: T-O Engineers
Airfield Markings

You're approaching a lit runway for landing. What color are the threshold lights?

You're taxiing and see this painted on the concrete. What does it mean?
Airfield Markings

You're landing and you see this sign on the side of the runway. What does it mean?

What color are taxiway centerlines?

Ground control tells you to hold short of runway 33. What sign are you looking for?

Source: www.boldmethod.com
Additional Considerations

- **307 - Runway Safety Area**
  - On rwy C/L – NO OBJECTS HIGHER THAN 3”, except those necessary for their function (e.g., NAVAID)

- **308 - Runway Object Free Zone**
  - Volume of airspace above rwy C/L – precludes aircraft and other object penetrations except frangible NAVAIDs

- **309 - Runway Object Free Area**
  - On rwy C/L – clear of objects protruding above nearest point of RSA (e.g., LOC, GS)

- **310 - Runway Protection Zone**
  - Seeks to protect people and property on the ground. Control generally sought through purchase of property.
TERPS

• FAA Order 8260.3B
• Instrument Approach & Departure Minimums
  o Approach:
    o Most require: 20:1 OCS (34:1 for vis < ¾ SM)
  o Departure:
    ▪ 40:1 OCS (152 ft/NM)
    ▪ Std Climb (200 ft/NM)
    ▪ OEI Climb Gradient? - NO
• If obstacles penetrate OCS:
  o Reduce TODA
  o Non-Std Climb Gradient
  o Increase Vis required
• Not all TERPS criteria are contained in FAR Part 77 Surfaces

What does this correspond to? Hint: Glideslope

Source: www.AirNav.com
Standards for Instrument Approach Procedures

<table>
<thead>
<tr>
<th>Visibility Minimaums ¹</th>
<th>&lt; 3/4 statute mile</th>
<th>3/4 to &lt; 1 statute mile</th>
<th>≥ 1 statute mile straight-in</th>
<th>Circling ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>HATH ³</td>
<td>&lt; 250 ft</td>
<td>≥ 250 ft</td>
<td>≥ 250 ft</td>
<td>≥ 350 ft</td>
</tr>
<tr>
<td>TERPS GQS ⁴</td>
<td>Clear</td>
<td>Clear</td>
<td>Clear</td>
<td>Not applicable</td>
</tr>
<tr>
<td>PA final approach surfaces ⁵</td>
<td>Clear</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not applicable</td>
</tr>
<tr>
<td>POFZ (PA &amp; APV only)</td>
<td>Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not applicable</td>
</tr>
<tr>
<td>TERPS Chapter 3, Section 3</td>
<td>34:1 clear</td>
<td>20:1 clear</td>
<td>20:1 clear ⁶</td>
<td>20:1 clear ⁶</td>
</tr>
<tr>
<td>ALP ⁷</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
<td>Recommended</td>
</tr>
<tr>
<td>Minimum Runway Length</td>
<td>4,200 ft (paved)</td>
<td>3,200 ft ⁸,⁹</td>
<td>3,200 ft ⁸,⁹</td>
<td>3,200 ft ⁸,⁹</td>
</tr>
<tr>
<td>Runway Markings (See AC 150/5340-1)</td>
<td>Precision</td>
<td>Non-precision ⁹</td>
<td>Non-precision ⁹</td>
<td>Visual (Basic) ⁹</td>
</tr>
<tr>
<td>Holding Position Signs &amp; Markings (See AC 150/5340-1, AC 150/5340-18)</td>
<td>Precision</td>
<td>Non-precision ⁹</td>
<td>Non-precision ⁹</td>
<td>Visual (Basic) ⁹</td>
</tr>
<tr>
<td>Runway Edge Lights ¹⁰</td>
<td>HIRL / MIRL</td>
<td>HIRL / MIRL</td>
<td>MIRL / LIRL</td>
<td>MIRL / LIRL (Required only for night minimums)</td>
</tr>
<tr>
<td>Parallel Taxiway ¹¹</td>
<td>Required</td>
<td>Required</td>
<td>Recommended</td>
<td>Recommended</td>
</tr>
<tr>
<td>Approach Lights ¹²</td>
<td>MALSR, SSALR, or ALSF</td>
<td>Recommended ¹³</td>
<td>Recommended ¹³</td>
<td>Not Required</td>
</tr>
<tr>
<td>Applicable Runway Design Standards, e.g. OFZ</td>
<td>&lt; 3/4-statute mile approach visibility minimums</td>
<td>≥ 3/4-statute mile approach visibility minimums</td>
<td>≥ 3/4-statute mile approach visibility minimums</td>
<td>Not Required</td>
</tr>
<tr>
<td>Threshold Siting Criteria To Be Met (Reference paragraph 303)</td>
<td>Table 3-2, row 7</td>
<td>Table 3-2, row 6</td>
<td>Table 3-2, rows 1-5</td>
<td>Table 3-2, rows 1-4</td>
</tr>
<tr>
<td>Survey Required ¹⁴</td>
<td>VGS</td>
<td>VGS (PA &amp; APV)</td>
<td>NVGS</td>
<td>NVGS ¹⁵</td>
</tr>
</tbody>
</table>

ALP – Airport Layout Plan
GQS – Glide Path Qualification Surface
PA – Precision Approach
POFZ - Precision Obstacle Free Zone

Source: AC 150/5300-13A Table 3-4
Do you need DME for this approach?

Celtic Cross = Final Approch Fix (NPA)
Lightning Bolt = FAF (PA)
Co-located on this IAP

Visual Descent Point = earliest location a visual descent can commence with required visual references (AVRRRRTTTTTTTNormalVis)

Declared Distance Information is available
What is the lowest altitude you can initiate a turn on a departure?
What does that color mean?
Wow…Let’s put that together
How far and what direction is the airport from Boise?

On what sectional and low level chart can this airport be located?

What is the ASDA for 10L?

What does it mean if the TORA and TODA are the same?

What frequency is the VOT?

What indication on the VOR CDI/OBS indicates a correct signal from the VOT?
**What is the TORA for RWY 13?**

**What is the TODA for RWY 13?**

**What is the ASDA for RWY 13?**

**What is the LDA for RWY 13?**

**WHAT??!!??**

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**FRIEDMAN MEM**  
**Source:** SkyVector

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**RWY 13/31:**

**TORA:** 7150 ft

**TODA:** 7550 ft

**ASDA:** 7150 ft

**LDA:** 5450 ft

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**AIRPORT REMARKS:**

- Attended dawn-dusk. Fuel avbl after dusk PPR.
- 208-788-9511. Class I, ARFF Index A. ARFF avbl 1400-0600Z.
- ATCT 275° east of Rwy 13-31 cntrln. Aftld sfc cond not monitored bth the hrs of 0600Z and 1400Z.
- Brd activity southeast end Rwy 31. When twr clsd land Rwy 31 tfl Rwy 13 due to opposite direction tfl.
- Use ldg lghts in tfl pat. Due to opposite tfl, apch Rwy 31 along east side of valley. Depart Rwy 13 along west side of valley. Show ldg lght. Ctc aprt mgr 208-788-4956 or 208-720-5186 for NS ABTMT procedures.
- Rwy 13-31 ltd to acft not exceeding 95,000 lbs certificated max tfl weight, dual wheel. Acft with published max tfl weight exceeding 95,000 lbs must seek prior permission by submitting to aprt mgr a manufacturer's act svr change that installs a placard verifying acft is certificated for SUN with a max tfl weight of 95,000 lbs. APU ops ltd to 30 minutes maximum run time. Not recommended for ngt use or in marginal wx by unfamiliar pilots due to mountainous terrain. Twy A open between Twys A2 and A3 dght hrs only. Twys B5 and B6 rstd to acft with wingspans of 79° or less (Acft Design Group II) only. PPR for all scheduled air carrier ops bth 0600-1300Z call aprt mgr 208-788-4956. No locked brake turns. All trn parking ctc 208-788-9511. Ltd parking avbl for air carrier acft. ACTIVATE HIRL Rwy 13-31—CTAF when twr clsd. PAPI Rwy 31 opr 24 hrs. Ldg fee for acft greater than 6,000 lbs.

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**AIRPORT MANAGER:** 208-788-4956

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**WEATHER DATA SOURCES:** AVOS—3 128.225 (208) 788-9213.

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**COMMUNICATIONS:** CTAF 125.5 ATIS 128.225 (208) 788-2138 UNICOM 122.95

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**HAILEY RCO** 122.4 (BOISE RADIO)

**SALT LAKE CENTER APP/DEP CON** 118.05

**HAILEY TOWER** 125.5 (1400-0600Z) GND CON 121.7

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**AIRSPACE:** CLASS D svc 1400-0600Z other times CLASS E.

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**RADIO AIDS TO NAVIGATION:** NOTAM FILE BYU.

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**BURLEY (LU) VOR/DME** 114.1 BYI Channel 88 N42°34.81’ W113°51.95’ 323° 58.5 NM to fld. 4226/18E.

**VOR/DME usable:**

- 120°-150° byd 30 NM bly 15,000’

**HAILEY NDB/DME (MHW)** 220 HLE Channel 25 N43°19.79’ W114°14.62’ 335° 10.7 NM to fld. NOTAM FILE SUN. NDB/DME unmonitored.

**DME usable:**

- 080°-280°

**NDB usable:**

- 310°-350° byd 6 NM

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**COMM/NAV/WEATHER REMARKS:** Emerg frequency 121.5 not avbl at twr.
What is this symbol?

What symbol represents the limit of the TORA?
What is a Hot Spot?
Accident Data
Approach and Departure Accident Trend

GA Accidents-Approach
Rwy 4000-5,999 ft
Source: CA Airport Land Use Planning Handbook Figure 3F

GA Accidents-Departure
Rwy 4000-5,999 ft
Source: CA Airport Land Use Planning Handbook Figure 3G
Questions?

• Checkout the site:  www.boldmethod.com