Runway Protection Zones: Incompatible Land Use Alternatives Analysis & Risk Assessment

March 3rd, 2015

FAA Guidance on RPZ Land Use

Trigger for Analysis

- In September 2012, the FAA issued interim policy guidance on Land Uses within RPZs; to address what constitutes a compatible land use and how to evaluate proposed land uses contained within an RPZ.
- FAA is now requesting Airports analyze RPZ land use conditions if a land use change is being proposed as a result of:
  - An airfield project (e.g. runway extension, runway shift)
  - A change in the critical aircraft that increases the RPZ dimensions
  - A new or revised instrument approach procedure that increases the RPZ dimensions
  - A local development proposal in the RPZ (either new or reconfigured)
- An Alternatives Analysis of existing and proposed Incompatible Land Use conditions within an RPZ provides information to the FAA to allow them to determine whether the future actions of a proposed plan (e.g. Master Plan/ALP) are sufficient to meet the FAA RPZ land use compatibility guidance
### FAA Process for Evaluating RPZ Land Use

#### Examining the Guidance

<table>
<thead>
<tr>
<th>FAA Guidance</th>
<th>Documentation Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior to contacting APP-400, the RO and ADO staff must work with the airport sponsor to identify and document the full range of alternatives that could:</td>
<td>Documentation of the alternatives should include:</td>
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<td>- Avoid introducing the land use issue within the RPZ</td>
<td>- A description of each alternative including a narrative discussion and exhibits or figures depicting the alternative</td>
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<td>- Minimize the impact of the land use in the RPZ (i.e., routing a new roadway through the controlled activity area, move farther away from the runway end, etc.)</td>
<td>- Full cost estimates associated with each alternative regardless of potential funding sources</td>
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<td>- Mitigate risk to people and property on the ground (i.e., tunneling, depressing and/or protecting a roadway through the RPZ, implement operational measures to mitigate any risks, etc.)</td>
<td>- A practicability assessment based on the feasibility of the alternative in terms of cost, constructability and other factors</td>
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<td>Source: September 27, 2012, Federal Aviation Administration, Memorandum Subject: Interim Guidance on Land Uses Within a Runway Protection Zone.</td>
<td>- Identification of the preferred alternative that would meet the project purpose and need while minimizing risk associated with the location within the RPZ</td>
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### Summary of FAA Airport Design Standards

**RPZ Land Use Guidance**
Summary of FAA AC 150/5300-13A RPZ Guidance

RPZ Function

- Enhance the protection of people and property on the ground
- Where practical, airport owners should own the property under the runway approach and departure areas to at least the limits of the RPZ
- Desirable to clear the entire RPZ of all above-ground objects
- As a minimum, should maintain the RPZ clear of all facilities supporting incompatible activities

FAA AC 5300-13A land use guidance does not differentiate between the central portion and the controlled activity area of the RPZ

Summary of FAA AC 150/5300-13A RPZ Guidance

RPZ Dimensions

CODE A/B AIRCRAFT DESIGN GROUP
- Visual Approach and Instrument Approach No Lower than 1 mile
- Arrival and Departure Ends
  - 1,000’ long
  - 500’ wide near runway
  - 700’ wide at far end of RPZ
Summary of FAA AC 150/5300-13A RPZ Guidance

RPZ Dimensions

<table>
<thead>
<tr>
<th>CODE C/D/E AIRCRAFT DESIGN GROUP</th>
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<tr>
<td>Visual Approach and All Instrument Approach</td>
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</table>

• Arrival Runway Ends
  – 1,700’ long for runways with approach visibility of ¾ mile or more
  – 2,500’ for runways with approach visibility of less than ¾ mile
  – 1,000’ wide near runway
  – 1,510’ to 1,750’ wide at far end of RPZ

• Departure Runway Ends
  – 1,700’ long
  – 500’ wide near runway
  – 1,000’ wide at far end of RPZ

RPZ Permitted Land Uses

• AC 150/5300-13A, Paragraph 310.d permits the following land uses within an RPZ without further evaluation:
  – Farming that meets airport design standards
  – Irrigation channels that meet the requirements of AC 150/5200-33 and FAA/USDA manual, Wildlife Hazard Management at Airports
  – Airport service roads, as long as they are not public roads and are directly controlled by the airport operator
  – Underground facilities, as long as they meet other design criteria, such as RSA requirements, as applicable
  – Unstaffed NAVAIDs and facilities, such as equipment for airport facilities that are considered fixed-by-function in regard to the RPZ
Summary of FAA RPZ Interim Guidance (September 2012)

Incompatible Land Uses

- Transportation facilities Examples include, but are not limited to:
  - Rail facilities - light or heavy, passenger or freight
  - Public roads/highways
  - Vehicular parking facilities
- Above-ground utility infrastructure (i.e. electrical substations), including any type of solar panel installations
- Hazardous material storage (above and below ground)
- Wastewater treatment facilities
- Fuel storage facilities (above and below ground)
- Buildings and structures (Examples include, but are not limited to: residences, schools, churches, hospitals or other medical care facilities, commercial/industrial buildings, etc.)
- Recreational land use (Examples include, but are not limited to: golf courses, sports fields, amusement parks, other places of public assembly, etc.)

Incompatible Land Use Alternatives Analysis and Mitigation

Examining the Methodology
Outline of Alternatives Analysis

Objective

• The objective of a RPZ Alternatives Analysis is to identify preferred plans to improve compliance with FAA Airport Design Standards for Runway Protection Zones (RPZ) at the end of each runway

To Meet the Objective, the Alternatives Analysis.....

• Identifies existing and proposed land uses within the RPZs of each runway
• Identifies land ownership and control of existing compatible and incompatible land uses
• Identifies and evaluates physical, operational and engineering alternatives to avoid, minimize, or mitigate incompatible land uses
• Recommends a preferred alternative for each RPZ
• Evaluates the likelihood/risk of an fatal accident for each RPZs existing, proposed, and preferred alternative condition

Outline of Mitigation Techniques

Mitigation Approach (based on FAA Interim Guidance)

• Mitigation alternatives analyses usually recommend relocating incompatible uses:
  – Normally occupied buildings and structures
  – Recreational land uses
  – Fuel storage facilities
  – Parking lots
• Mitigation alternatives analyses often request FAA guidance for:
  – On-airport storage buildings
  – Above ground power lines that are not an airspace obstruction

• Our experience has been that mitigating transportation facilities becomes the focus of an alternatives analysis
**Mitigation Alternatives**

**Guiding Principals and Types of Alternatives**

- Three types of alternatives:
  - Group A: **Reroute** transportation facilities to avoid RPZ
  - Group B: **Tunnel** portion within RPZ
  - Group C: **Relocate RPZ** to avoid transportation facilities
- Possible to have two levels of RPZ mitigation strategies:
  - Entire RPZ
  - Central portion only
- Criteria for Group C Alternatives (relocated RPZ):
  - Should not reduce capacity & provide required lengths for both arrivals and departures of the most critical aircraft types
  - Should provide sufficient taxiways to reach runway ends without operational impacts in all weather conditions
  - Preferred Alternative should not increase the (average) likelihood of an accident within the RPZ when compared to the existing and future proposed condition

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**Examples of RPZ Incompatible Land Use Conditions**

- **A: Reroute**
- **B: Tunnel**
- **C: Relocate RPZ**

- Numerous public roads (incompatible land use) are located within the RPZ
- High volume transportation corridors, such major highway networks make mitigation very difficult
Examples of RPZ Incompatible Land Use Conditions

A: Reroute  B: Tunnel  C: Relocate RPZ

- Transportation corridors (incompatible land use) are located within the RPZ
- Environmental remediation site presents mitigation difficulties

Risk Assessment

Analyzing the Risk of Incompatible Land Uses
Outline of Risk Assessment

Study Goals and Approach

- Methodology originally developed for RSA Risk Assessment
- Based on historic accidents at U.S. airports and in other similar countries
- It was modified and adopted for assessment of RPZ risk
- Consequence focus was changed from onboard safety to ground safety

Types of Accidents

Overview

- Landing Overrun (LDOR)
- Takeoff Overrun (TOOR)
- Landing Undershoot (LDUS)
Probabilistic Risk Modeling Approach

Risk definition: Likelihood of the worst credible outcome (consequence)

• Three-Part Risk Model

  - Accident probability
    - Operating conditions (airplane performance, type of operation, runway distance available and elevation, weather conditions)

  - Location probability
    - Runway end characteristics

  - Consequences
    - Type, size and location of land use and population density

Risk Assessment

RPZ Risk Analysis Variables

**Background/Method/Techniques**

- **Accident Probability**: Likelihood of an aircraft off the runway
  - Type and characteristics of aircraft mix operating on all runways over one (or two) representative year
  - Runways declared distances (LDA, TORA)
  - Airport Weather condition during the representative year (visibility, ceiling, wind, fog, precipitation, etc.)
  - Type of operation (commercial, cargo, GA, air taxi)
  - Domestic or International
  - Number of landings and takeoffs challenging each RPZ
RPZ Risk Analysis Variables

Background/Method/Techniques

• **Location Probability**: Likelihood of a specific location to be crashed in
  – Size, configuration and location of incompatible land uses with respect to runway end
  – The farther the incompatible land use from the runway is, the lesser will be the accident likelihood

• **Consequence Model**: Likelihood of fatality at an incompatible land use
  – Occupancy density of incompatible land uses
  – On average, how many people are present at each incompatible land use within the RPZ

RPZ Risk Analysis

Background/Method/Techniques

• Only land use features within the limits of the RPZ are considered
• Risk is assessed for every incompatible land use feature separately making it possible to compare the risk of different incompatible features
• RPZ risk is the cumulative of the risk from all incompatible features within the RPZ
• Risk Metrics developed:
  – Annual risk of a fatal crash at RPZ
  – Number of years to an accident at RPZ
Outline of Risk Assessment

Background/Method/Techniques

Runway End

Runway RPZ

Commercial Facility

Airport Perimeter road

Local road

Commercial Facility

Airport Access Highway

Occupancy Measures at Common Incompatible Land Uses

Background/Method/Techniques

- Residential
  - Population per unit area

- Public roadway
  - Average annual daily traffic

- Railway
  - Average annual daily passes
  - Average annual daily passengers transported

- Pedestrian Walkway
  - Average annual daily uses

- Parking Lots
  - Average number of hours of operation
  - Daily usage
Risk Analysis Software

Runway Safety Area Risk Analysis (RSARA)

[Image of software interface]

Review of FAA Land Use Compatibility Guidance

Risk Assessment Key to Planning Process
Mitigation Alternative Example

Existing Condition of Runway 05/23

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>RPZ</th>
<th>Takeoff Runway Available (TORA)</th>
<th>Landing Distance Available (LDA)</th>
<th>% of Incompatible Land Use</th>
<th>Average Years to an Accident</th>
<th>Annual Risk of Fatality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>5</td>
<td>9,000'</td>
<td>9,000'</td>
<td>10%</td>
<td>110 Years</td>
<td>1.0%</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>9,000'</td>
<td>9,000'</td>
<td>0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Runway 23 end is used as a dominate arrivals flow
- Critical aircraft requires a minimum 9,000' of Landing Distance
- Roadways are located in the Runway 23 RPZ and just outside of the Runway 05 RPZ
- The highway located just outside the Runway 23 RPZ has high traffic volumes

Mitigation Alternative Example

Original Proposed Condition of Runway 05/23 (Trigger)

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<th>RPZ</th>
<th>Takeoff Runway Available (TORA)</th>
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<tr>
<td>Existing</td>
<td>5</td>
<td>11,600'</td>
<td>11,000'</td>
<td>10%</td>
<td>120 Years</td>
<td>0.3%</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>11,600'</td>
<td>11,000'</td>
<td>25%</td>
<td>90 Years</td>
<td>1.5%</td>
</tr>
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- Proposed 2,000' Runway extension to accommodate international service
- Critical aircraft requires a minimum 9,000' of Landing Distance
- Extension introduces major roadway into Runway 23 RPZ, results in 25% incompatible land use
- Impracticable to relocate transportation corridor around Runway 05 & 23 RPZ (Group A)
- Infeasible to tunnel large intersections and roadways inside Runway 05 & 23 RPZ (Group B)
- A relocation of Runway 05 RPZ reduced distances below minimum operational lengths (Group C)
- Relocation of Runway 23 RPZ proved to be only viable option (Group C)
### Mitigation Alternative Example

#### Incompatible Land Use Mitigation Alternative for Runway 05/23

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<tr>
<th>CONDITION</th>
<th>RFZ</th>
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<th>Landing Distance Available (LDA)</th>
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<td>10%</td>
<td>110 Years</td>
<td>1.0%</td>
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<tr>
<td>Original Proposed</td>
<td>23</td>
<td>11,000'</td>
<td>11,000'</td>
<td>10%</td>
<td>120 Years</td>
<td>0.8%</td>
</tr>
<tr>
<td>Incompatible Land Use Alternative</td>
<td>23</td>
<td>11,000'</td>
<td>9,000'</td>
<td>5%</td>
<td>105 Years</td>
<td>2.0%</td>
</tr>
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- Shift Runway 23 RPZ 2,000' to minimum LDA; maintain required Runway length for critical aircraft
- Incompatible land use was reduced to 5%
- However, the risk of accident in the Runway 05 RPZ increased due to the shorter LDA provided for Runway 23 RPZ arrivals
- The increased risk of a landing overrun accident in 05 RPZ did not compensate for the reduction of a landing undershoot risk in 23 RPZ.

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### Mitigation Alternative Example

#### Final Preferred Alternative for Runway 05/23

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- Accept the original proposed condition for Runway 05/23; provides lowest level of risk
Presentation Summary

What We Learned.....

Risk Assessment is desired when

- Runway declared distances are altered
  - Threshold displacement
  - Runway extension
- Land use within the RPZs is altered
  - New incompatible land use is introduced
  - An existing incompatible land use is altered in location, size or population density
- Runways movement mix is altered
  - Introduction of larger aircraft types
  - Growth in airport movement
  - Commissioning a new runway or de-commissioning an existing one
- Risk exposure estimate to people on the ground is sought under existing condition
  - Average number of years to an accident for every RPZ

Questions?

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