DEVELOPING FORMAL DESIGN GUIDELINES FOR SPACEPORTS

Presentation Number: P15-6860

2015 TRB 94TH ANNUAL MEETING
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Agenda

» Overview of Spaceports
  – Concept and Functions
  – Multimodal Aspects
  – Current Governing Regulations
» Background and Challenges
» Spaceport Research Needs
» Summary
Spaceport Concept and Functions

- Launch Vehicle
- Propellants
- Ordnance
- Passengers
- Crew
- Cargo
- Experiments

SPACEPORT

Public

Education/Training

- Beyond Earth Orbit
- Orbital/Suborbital
- Environment/Earth
Spaceport Multimodal

Launch Vehicle

Launch Vehicle

Launch Vehicle

Propellants

Ordnance

Passengers

Crew

Cargo

Experiments

Beyond Earth Orbit

Orbital / Suborbital

Environment / Earth
Governing Regulations

» Commercial Launch Sites and Spaceports
  – 14 CFR Part 420 – FAA - License to Operate a Launch Site
    • Environmental analysis
    • Explosive site plan
    • Launch site operations
    • Flight corridor and risk analysis

» Federal Launch Sites and Spaceports
  – Numerous regulations depending on the operator/user and are derived from range safety requirements
    • Eastern and Western Range requirements
    • Range Commanders Council requirements
    • NASA specifications, standards, and handbooks
    • DoD regulations
Agenda

» Overview of Spaceports
» Background and Challenges
  – Types of Spaceports / Vehicles
  – Transportation interactions Spaceports require
  – Coordination areas with different organizations
  – Integrating horizontal spaceport ops with airports
  – Experience with integrating spaceport ops with air traffic
» Spaceport Research Needs
» Summary
Types of Vehicles

Operations variability challenges:

» Vertical Takeoff / Horizontal Takeoff
  – (Antares / Pegasus)

» Rocket Powered takeoff / Aircraft Powered takeoff
  – (Lynx / SpaceShipTwo)

» Reentry: with/without recovery; at /remote
  – (Cygnus, CST-100, SpaceX Grasshopper)
Types of Spaceports

Variety of Vehicles is Enabling and Challenging!

» Specialize:
  – Suborbital, Horizontal Launch Spaceports (Cecil Field, Ellington Field), usually combined with operational airport.
  – Vertical launch spaceports, (Kodiak Launch Cx; MARS)

» Full Service:
  – Purpose built Spaceports which serve all type of vehicles, “Spaceport America”.
  – Multi use Government built facilities, KSC, WFF, Space Florida, CCAFS, Vandenberg
Multimodal Challenges

Ideal Modes Available:

» Rail
» Port
» Highway
» Air
» Space
Organization Coordination

Coordination with both federal and local government agencies is required.

» FAA Offices
  – Commercial Space (AST)
  – Office of Airports (ARP)
  – Air Traffic Control (ATC)
  – Airline Dispatch Office (ADO)

» U.S. Coast Guard

» Other (as required)
  – Local government organizations
  – Federal organizations
    • NASA
    • DoD

» Licensure
  – License
  – Airport Layout Plan
  – Airspace
  – Regional Dispatch

» Letters of Agreement
Spaceport/Airport Ops Integration

It is especially challenging to integrate spaceport and airport operations at airports as spaceport operations are typically considered secondary to airport operations.

» At first glance horizontal RLVs operate similarly to traditional aircraft

» Complications of integration
  – RLV may not have taxi or loiter capability
  – Less frequent flights for horizontal RLVs
  – Hazardous propellant storage and building locations
  – Hazardous propellant combinations on takeoff and during flight
  – Operational weather conditions

» FAA Airport grants may exclude facility use by spaceports
No operational experience yet integrating spaceport ops with Part 139 airport operations

- Midland International Airport first Part 139 airport with spaceport operator license granted September 2014
- Proposed Spaceports: Ellington Airport & Kona International

Limited experience integrating spaceport flight operations with air traffic

- Cecil Spaceport, Jacksonville, FL
  - Generation Orbit captive carry test flight (July 2014)
- Mojave Air and Space Port
  - Scaled Composites SpaceShipOne test flights
  - Virgin Galactic SpaceShipTwo test flights
  - XCOR Aerospace EZ-Rocket test flights
Agenda

» Overview of Spaceports
» Background and Challenges
» Spaceport Research Needs
  – Aircraft and horizontal RLV separation standards
  – Integrating spaceport and airport operations
  – Impacts / learnings from investigations of recent commercial failure investigations
  – Explosive Siting Standards Comparison
  – Summary of research topics and benefits

» Summary
Aircraft and Horizontal RLV Separation Standards

» To ensure the safety of the uninvolved public, policy updates and/or research into standardizing the separation distances between aircraft and spacecraft in flight should be performed

– Currently, airspace around and below flight trajectory of RLV must be sterilized to ground level
  • Temporary Flight Restriction +/- 1 hour before and after RLV flight
  • Includes carrier aircraft, such as WhiteKnightTwo

– Updating separation standards will ease the integration of spaceport with airport flight operations:
  • Provide real time separation
    – Reduce TFR pre/post period
    – Establish dynamic altitude separation
Integrating Spaceport/Airport Operations

» Typical spaceport operations are often similar to airport operations. Conducting operations with compatible standards that satisfy both spaceports & airports should be researched.

– Spaceport impact on airport design standards
– Lightning detection and weather monitoring
– Propellant loading procedures and equipment
– Spaceport scheduling process
– Aircraft Rescue and Fire Fighting
Aircraft Rescue and Fire Fighting Operations

» An effort is needed to equip and train airport Aircraft Rescue and Fire Fighting to prepare for the hazards associated with spaceport operations.

- ARFF services required at Part 139 airports
- ARFF services now classified based on size of aircraft
  - Expand for propellant types & quantities
- Include the local fire and police departments near spaceports
Impacts of 2014 on Data Gathering:

» Now underway are investigations of two recent commercial launch failures from commercial spaceports.

» These investigation may also be used to bring to light opportunities for spaceports to collect and record certain data, images, etc. which will enhance and improve future commercial spaceport operations.

» Post investigation analysis of the spaceport data and information gathering requirements
Explosive Siting Standards Comparison

» Aircraft and RLVs each can contain fuels and oxidizers.
  – Are aircraft held to different standards than RLVs?

» Use of DOD explosive Safety Standard
  – DODM 6055.09 vs. Quantitative Risk Analyses
    • HAZEX/SAFER type analyses

» Hybrid and some solid propellants are underrepresented in the DODM

» Research Opportunities:
  – Develop FAA acceptance criteria for QRA analysis
  – Establish applicability for assigning explosive risk to RLVs
  – Supplement DODM to quantify and establish new hybrid propellant combination’s hazards
## Research Topic Benefits

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» Overview of Spaceports
» Background and Challenges
» Spaceport Research Needs
» Summary
  – Recommended Research Priorities
Recommended Research Priorities

1. Integration of Spaceport and Airport Operations
   - Lightning detection and monitoring
   - ARFF guidelines revision

2. QD Standards and Guidelines
   - Enabling for integrated operations

3. Enhanced Data Gathering

4. Aircraft and Horizontal RLV In Flight Separation Standards
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