Federal Aviation Administration

Commercial Space Transportation (AST)

Commercial Space Transportation RE&D Program

To: REDAC NAS Ops Subcommittee

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Director Commercial Space Integration

FAA Office of Commercial Space Transportation

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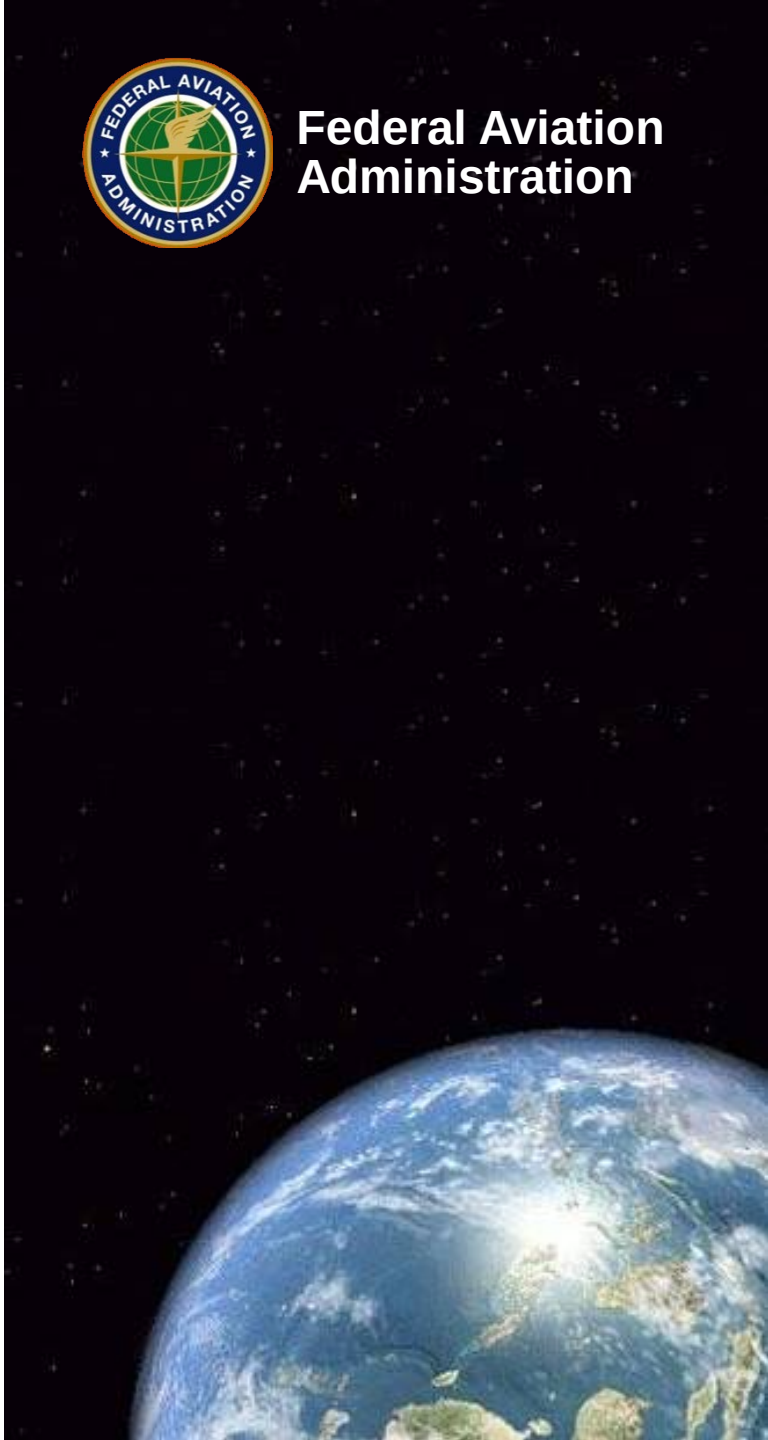


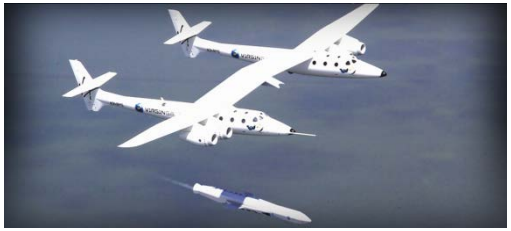
Agenda

- **Overview**
  - State of the Commercial Space Industry
  - Emerging Challenges
- **Commercial Space Transportation RE&D**
  - New Budget Line for FY16 & beyond
- **Summary & Discussion**

Expanding Commercial Capabilities

Industry Responding to Growing Market Demand

Virgin Galactic
"SpaceShipTwo"



Virgin Galactic
"LauncherOne"

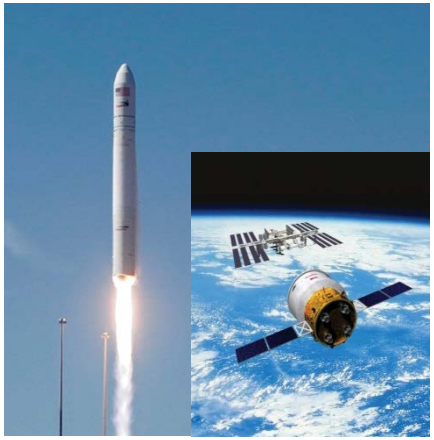
Boeing

XCOR Aerospace

Firefly

Rocket Lab

Blue Origin

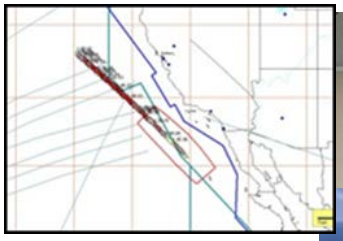
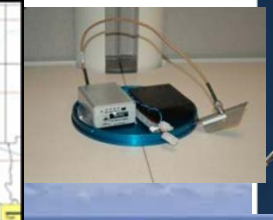
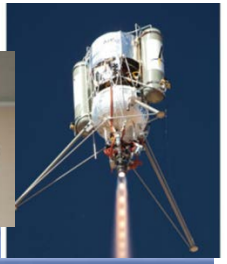


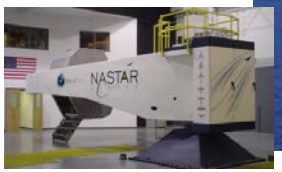
Orbital Sciences

Space X

Sierra Nevada Corp

AST Responsibilities, Products & Services

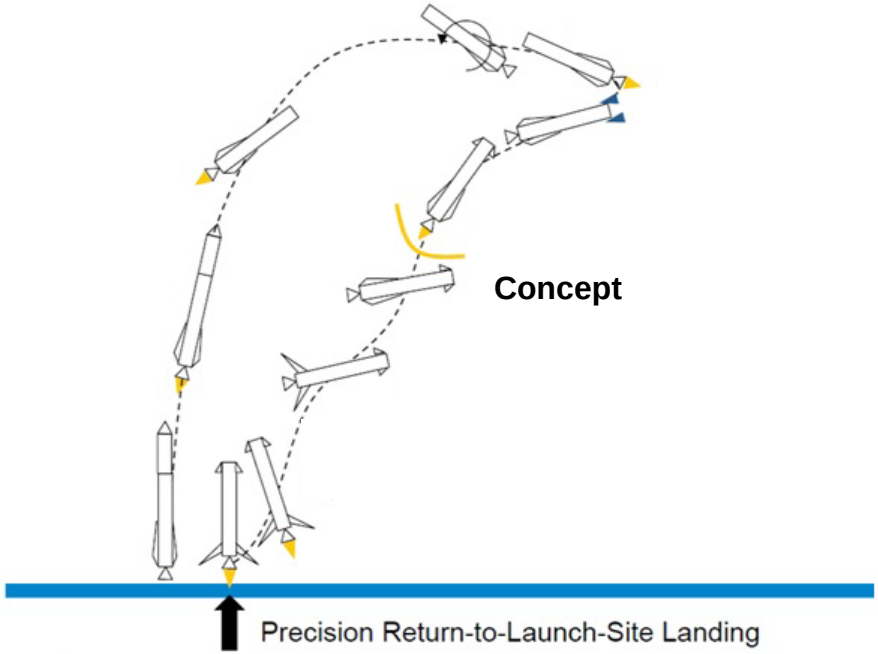


- **Licensing**
  - Launch and reentry vehicle operations
  - Launch and reentry site operations
- **Experimental Permits**
  - Suborbital Reusable Launch Vehicle (RLV) operations
- **Safety Approvals**
  - Systems, subsystems, and processes
- **Safety Inspections & Oversight**
  - Inspections and compliance monitoring for AST-issued licenses and permits
  - Mishap response & oversight

- **Environmental Review** (NEPA compliance)
- **Liability Determination** (e.g., “Maximum Probable Loss”)
- **Rulemaking**
  - Development and publication of regulations, guidelines, and Advisory Circulars
- **Infrastructure Development**
  - Spaceport (STIM) Grants (prior years)
  - Air-Space integration/coordination
  - Government partnerships
- **Research**

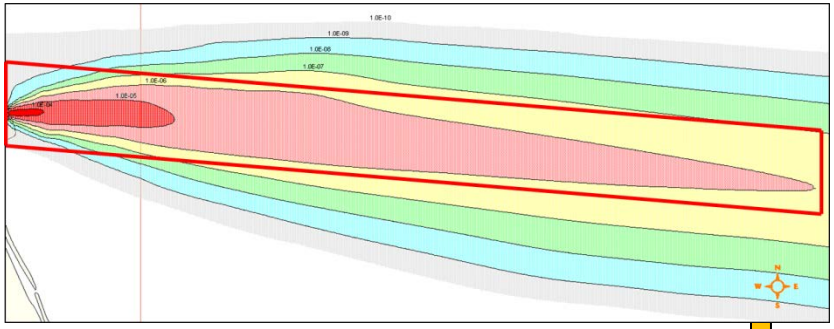
Increasing Complexity Highlights a Number of R&D Challenges

Blue Origin PM 2 (11/23/2015)



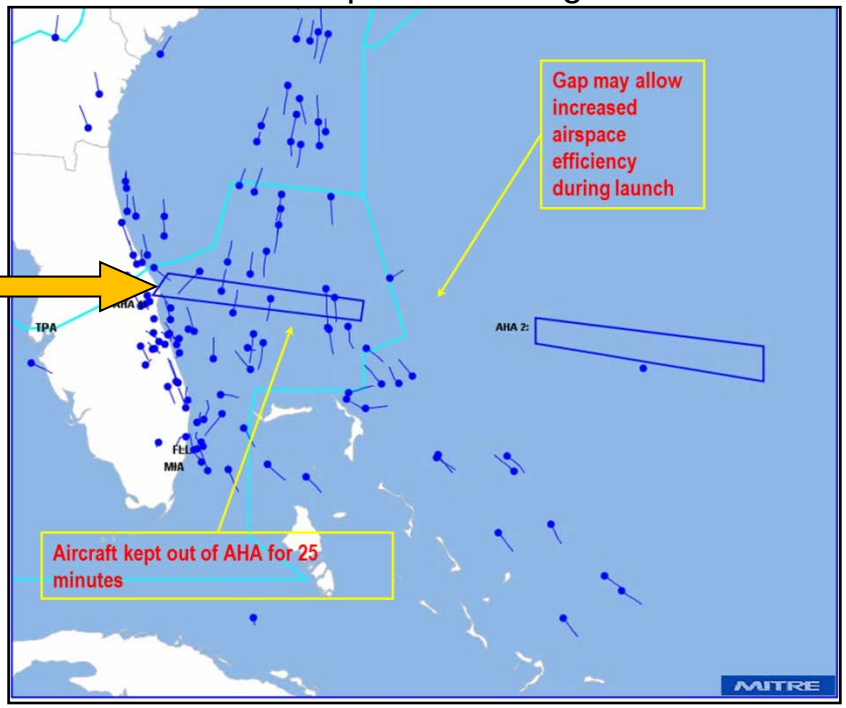
SpaceX ORBCOMM-2 (12/21/2015)

Illustration: Aircraft Hazard Areas (AHAs) Protect Aircraft from the Consequences of Launch



Example of Calculated Risk Contours

Airspace Planning & Prioritization



PPT Portfolio Overview

- **The Commercial Space Transportation RE&D portfolio will enable advances in critical areas such as:**
  - Safe and efficient integration of increased commercial space launch and reentry activity in to the national airspace
  - Advanced safety assessment methods
  - Advanced vehicle safety technologies and methodologies, and
  - Human space flight safety and physiology factors
- **Funding enables maturation of concepts for follow-on use in methods, systems, operations and the regulatory framework**
- **Funding also sustains cooperative, innovative R&D within the FAA's Commercial Space COE**

NARP BLI Milestone Summary

- **FY2016 President's request included Commercial Space Transportation Safety RE&D budget line for the first time**
  - Appropriation $2M vs $3M requested
  - Funding will be split: $1M new applied program, $1M Center of Excellence
- **Detailed planning for specific FY16 milestones and beyond continues based on appropriations uncertainty**
- **Funding profile:**

	FY16 Approp	FY17 PBR	FY18	FY19	FY20	FY21
Funding Target ($000)	2,000	3,000	5,000	5,000	5,000	5,000

NARP BLI Milestone Development

- **Research projects within *Safe and Efficient Integration* may include:**
  - **Improving integration of launch sites (i.e., spaceports) into the NAS and its system of airports**, including sites in the vicinity of major airports or complex airspace.
  - **Exploring the development of separation standards** for improved airspace management of launch/reentry vehicles during non-explosive phases of flight.
  - **Improving airspace integration planning** for return to land-based sites to decrease the amount of airspace closed to air traffic operations by using higher fidelity input data and models.
  - **Improving real-time monitoring of launch/reentry vehicle operations for airspace integration**, to decrease the amount of airspace closed to regular air traffic operations and expedite response to off-nominal scenarios.
  - **Developing and validating improved noise models for commercial space launch operations at inland launch sites**, including spaceports co-located with airports.
  - **Improving methods for launch and reentry collision avoidance analysis** to produce more efficient launch and reentry planning and NAS integration.

NARP BLI Milestone Development

- **Research projects within *Advanced Safety Assessment Methods* may include:**
  - **Exploring advanced commercial space flight data sharing and mining capabilities** to inform safety assessments and identify emerging safety issues.
  - **Improved methods to evaluate failure probabilities for launch and reentry vehicles.**
  - **Advanced study and model development of break-up characteristics of space vehicles**, such as hybrids or other new concepts currently under consideration.
  - **Improved safety analysis methods to assess and manage hazards to dynamic population clusters,** such as for the public on roads and rail.
  - **Improved understanding of aircraft vulnerability to space-vehicle-breakup debris**, including model development and refinement to reduce over-conservatism applied to airspace “keep out” areas used to protect against a launch or reentry vehicle failure.

NARP BLI Milestone Development

- **Research projects within *Advanced Vehicle Safety Technologies* may include:**
  - **Improved understanding of emerging autonomous flight safety systems** and exploring mitigation factors to address their potential vulnerabilities.
  - **Exploring the repetitive use considerations for high utilization reusable space vehicles**, to include assessing the use of integrated vehicle health monitoring technologies and reentry breakup recorders when applicable.

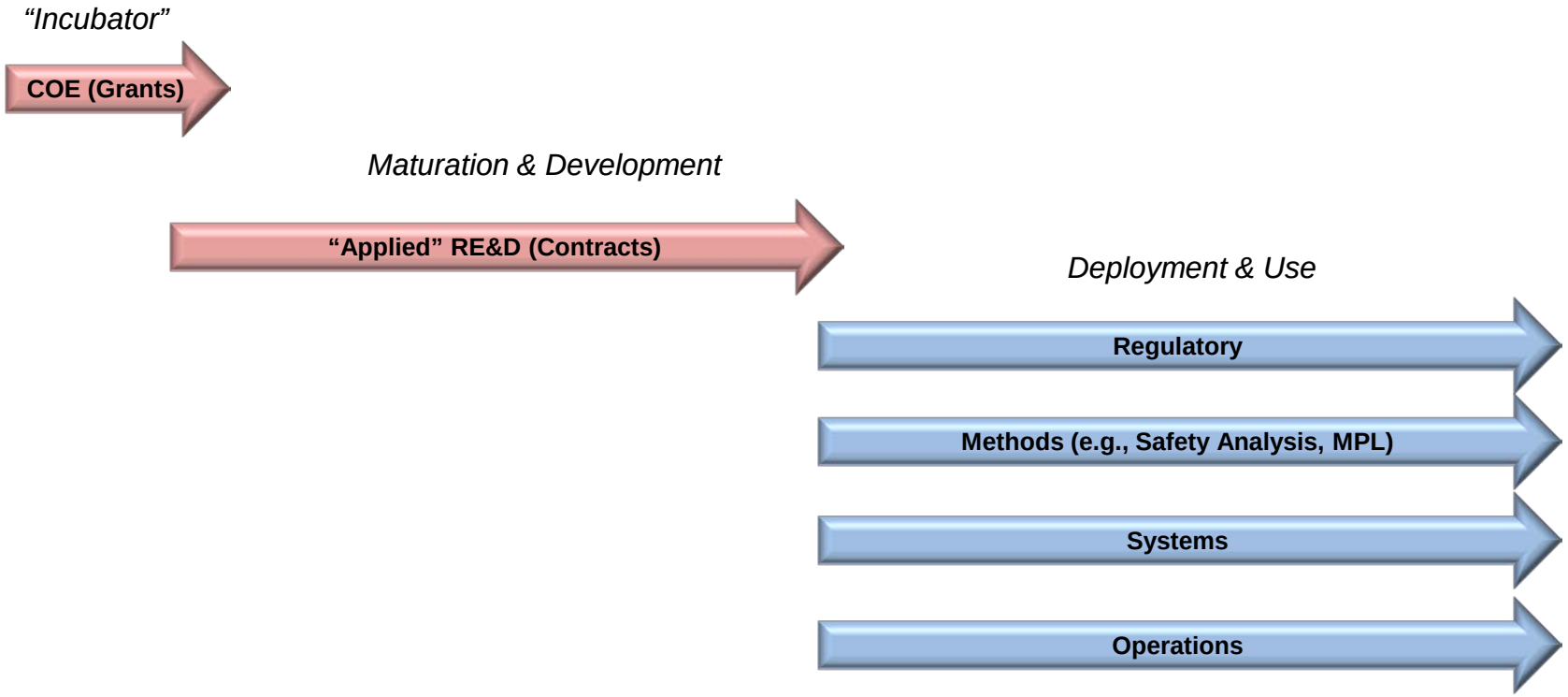
NARP BLI Milestone Development

- **Research projects within *Human Spaceflight and Physiological Safety Factors* may include:**
  - **Improved crew safety systems** for proposed space flight vehicles, including **systems to monitor the cabin environment and support safety actions** in the event of contingencies.
  - **Voluntary physiological data collection from both human spaceflight participants and crew**, including those participants who may possess common disease states (such as high blood pressure, diabetes, lower back injury, respiratory disease, etc.), to identify potential areas of concern and additional focus.
  - **Identifying best practice considerations for crew human factors** for small winged commercial spaceflight vehicles.

Summary

- **US Commercial Space Transportation industry is dynamic and growing**
  - Increased demand for services, operational tempo
  - Increased complexity and innovation drive critical research needs
- **FAA initiated a new Commercial Space Transportation Safety RE&D BLI in the FY2016 Presidents Budget Request**
- **A robust Commercial Space Transportation RE&D program will allow the FAA to keep pace**
  - Continued public safety
    - Improved analysis methods and evaluation of applications
    - Responsive and effective regulatory and policy framework
  - Safe and efficient integration of operations
  - Continued industry innovation and safety improvement

Enabling Enhanced R&D Portfolio to Impact High Priority Areas



RE&D Funding

Capital & Ops Funding (FAA)
FAA & Industry Use

“Like launching a pencil over the Empire State Building, having it reverse, come back down and land on a shoebox on the ground – in a windstorm”