

## **Center of Excellence for Commercial Space Transportation Study**

**Subject:** 2.20- Establish a Framework to Capture a Body of Knowledge for Commercial Spaceport Practices through 2012

### **Investigation Team:**

- Principal Investigator: Patricia Hynes – [pahynes@nmsu.edu](mailto:pahynes@nmsu.edu)
- Co-Investigator: Herbert K. Bachner, CSSI, Inc. - [hbachner@cssiinc.com](mailto:hbachner@cssiinc.com)
- Co-Investigator: Jennifer Meixell, CSSI, Inc., [jmeixell@cssiinc.com](mailto:jmeixell@cssiinc.com)
- Co-Investigator: Nick Tongson, AIAA – [nickt@aiaa.org](mailto:nickt@aiaa.org)
- Co-Investigator: Jim Hayhoe, SAC LLC - [jimhayhoe3@msn.com](mailto:jimhayhoe3@msn.com)
- Co-Investigator: Paul Arthur, Rear Admiral (Ret.) - [paul.k.arthur@comcast.net](mailto:paul.k.arthur@comcast.net)
- Co-Investigator: Craig Day, AIAA - [craigd@aiaa.org](mailto:craigd@aiaa.org)

### **Advisory Committee:**

- Aaron Prescott, Spaceport America – [aaron.prescott@spaceportamerica.com](mailto:aaron.prescott@spaceportamerica.com)
- Stu Witt, General Manager, Mojave Air and Space Port – [stuart@mojaveairport.com](mailto:stuart@mojaveairport.com)
- Billie Reed, Mid Atlantic Regional Spaceport - [breed@vaspace.org](mailto:breed@vaspace.org)
- Klaus Dannenberg, AIAA - [klausd@aiaa.org](mailto:klausd@aiaa.org)
- Joe Bullington, Jacobs Technology - [joe.bullington@nasa.gov](mailto:joe.bullington@nasa.gov)

### **Objective of the Research:**

Develop an accepted framework to capture a body of knowledge for commercial spaceport practices through 2012. Once the framework and processes are established, and proven to be useful, further individual practices may be developed by the spaceport community, the launch provider community, the FAA, NASA, and other users of commercial launch services on a priority basis as needed as the industry evolves.

### **Background:**

Today's space access systems do not employ standard systems allowing spaceports, ranges, and launch providers to interoperate in the seamless manner needed to stimulate a vibrant commercial space industry. The challenges for the long-term vision of interoperable or harmonious spaceport services for spaceports, operators, and customers are being initially examined in this project. Today's pattern of individual launch sites tailored uniquely to each vehicle's design and operations infrastructure (similar to the way vertical launch systems are developed today) will give way to a new generation of interoperable space launch sites with services designed to fulfill the demand of the emerging commercial space industry. Ground operations standards and procedures will also evolve to support the long-term vision of interoperable spaceports.

The 8 licensed launch sites now exist in the United States. There is also a growing related technical, business, and professional communities supporting and supplying these spaceports. The growth of the supply chain is a leading indicator of the timeliness of this task. Key near-term needs to examine the potential for harmonious spaceport operations include the development of

operational procedures, including fuel handling, safety risk management, and interface practices. Longer term needs include training and certification of personnel and promotion of policymaker awareness of policies and regulations needed for fiscally viable, safe commercial spaceport operations.

It is useful to keep in mind implementation of standards is not necessarily a requirement for routine access to space. As long as a single spaceport only works with a single launch provider, there is no need for the implementation of a broad range of standards. When either the launch provider or the spaceport works with multiple parties for the same functions, the need for standardization emerges as a function of maturity. Responding to this maturity is a way to assure investors and participants the FAA AST is current on their understanding of the state of the industry.

It is our hypothesis that in a complex system, the existence of a Body of Knowledge for commercial spaceport practices is a major tool to reduce cost when implementing multiple types of space missions. For the purpose of this study, Body of Knowledge is defined as an evolving collection of documents and information pertaining to commercial spaceport practices.

The current licensed spaceports have a wealth of technical information and practical experience that should be captured and catalogued as it currently exists. One justification of capturing a current “snapshot” of the status of licensed spaceports is to information dissemination among the community members. Another beneficial outcome will be to eventually enable faster work flow for vehicles operating from multiple spaceports, increase spaceport interoperability, and enhance collaboration, innovation and creativity.

Spaceport developers will likely benefit from an examination of lessons learned within the aviation industry, such as the National Airspace System that standardizes air traffic operations throughout the United States. Inclusion of the Range Commanders Council as advisors to this project will also contribute to the comprehensive examination of salient topics regarding spaceport operations.

The purpose of this study is to establish a framework for the development of a body of knowledge on spaceport operations. It is not to develop or advocate for the development of standards. It is, however, evident that in the future, clear, well-written, community consensus standards will enable spaceport operator and launch providers to come together, because they describe what spaceports do and how they will do it. Task 3, the final deliverable from this study will be to submit a gap analysis that will compare the framework constructed as the deliverable of Task 1 with the Existing Standards identified in Task 2. Task 3 will be completed by the end of 2013.

Spaceport developers and operators are now working with launch providers. Spaceport developers who work to integrate systems capable of handling a variety of vehicles will be the leaders of the emerging commercial space transportation industry. The commercial market and current technology will drive design considerations. As new spaceports emerge (or are developed) and point-to-point operations become a reality, substantially more interfaces will be needed. Future studies on spaceport planning and development are addressed in “Future

Considerations for Study” at the end of this section. A reasonable assumption of the commercial space transportation industry is there will be new facilities developed. As the existing facilities come online, to ensure initial spaceport success and return on investment, key components of spaceports systems, related interfaces, and operations should be identified to help establish future requirements.

By working together, spaceport operators, launch providers, and vehicle manufacturers will drive each other’s development. Vehicle manufacturers are expected to drive the evolution of spaceport infrastructure just as they have done with airport infrastructure. Spaceports can serve as an effective home for new vehicles with the development of up to date interfaces and operations that have been defined and implemented. Consequently, we recommend the first order of business be to define a viable and accepted framework to capture commercial spaceport practices that can be used by all relevant stakeholders.

#### **Future Considerations for Study:**

- Spaceport Planning and Design Requirements (i.e., answers the question, “what constitutes a spaceport?”).
- Develop spaceport planning and systems analysis techniques; use these tools to derive spaceport requirements.
- Create a spaceport facility directory.
- Aeronautical Charting (e.g., creating spaceport-related symbology for use in FAA aeronautical charts, etc.)

#### **Approach to Study 2011-2013:**

The approach consists of 3 tasks with limited iterative overlap, as follows.

**Task 1 Framework:** Appendix 1 contains the initial classification framework that will be used for the study of a body of knowledge for commercial spaceport practices through 2012. There will be a periodic review of Appendix 1 by industry representatives and others, as well as spaceport executive directors. The framework is intended to be a living document and will be revised and refined in future years as the community evolves.

A sub-task under all three of the tasks will include periodic industry peer review and quarterly updates to industry stakeholders.

**Investigators:** Pat Hynes, Jim Hayhoe, Paul Arthur, Herb Bachner, Jennifer Meixell

**Student Researcher:** Morgan McPheeters

**Task 2 Research into Existing and Applicable Practices, Documents, and Other Relevant Materials:** The study will be conducted to capture documents related to existing standards from all sources applicable to commercial spaceports. Task will start January 1 and will be completed by December 31, 2012.

**Investigators:** Pat Hynes, Judy McShannon, Jim Hayhoe, Paul Arthur, Herb Bachner, Jennifer Meixell

**Task 3 Gap Analysis:** A gap analysis will be conducted to compare the Framework of Task 1 with the Existing Standards identified in Task 2. Task 3 will be completed by the end of 2013.

**Investigators:** Pat Hynes, Judy McShannon, Herb Bachner, Jim Hayhoe, Paul Arthur, Jennifer Meixell

## SCHEDULE 2011-2012

- Authorization to Proceed (ATP)

### Task 1: Framework

- Prepare questionnaire for spaceport executive interviews
- Interview current spaceport executives for input on best practices for efficient spaceport operations around initial framework in Appendix 1
- Present survey results to FAA and interested industry groups
- Update framework to account for input from current spaceport operators – ATP + 10 months (March 1, 2011 – October 30, 2011)

### Task 2: Research into Existing and Applicable Standards

- Identify common operational processes among existing and proposed spaceports
- Review existing FAA commercial spaceflight regulations
- Building on feedback from current spaceport executives, review existing FAA airport operations regulations to identify potential overlap with spaceports
- Using framework topics identified in Task 1, review all available databases to identify any existing standards applicable to spaceport needs
- Develop matrix of existing standards mapped to framework areas and present for industry peer review – ATP + 12 months (January 1– December 31, 2012)

### Task 3: Gap Analysis

- Rank framework areas in order of need for safe, efficient, and common spaceport operations
- Review existing standards identified in Task 2 to determine applicability to spaceport operations as-is or with tailored requirements
- Present framework for industry peer review that includes a prioritized list of framework areas and whether a need can be met by an existing standard “as is”, an existing standard with tailoring, or possibly the need for a new standard may be indicated – ATP + 12 months (January 1, 2013 – December 31, 2013)

## **Report:**

Expected benefits and outcomes

**Schedule – Include 6 month milestones:**

The schedule as indicated in Tasks 1-3.

**Management**

The project will be led by Pat Hynes, as the principal investigator. Dr. Hynes will provide oversight and direction to each of the 3 task leaders and will be the primary interface with the FAA. The 3 task investigators will each be responsible for execution of their respective task activities, for development of the outputs identified for each task, and for incorporation of perspectives of the other participants identified in this proposal.

APPENDIX 1

*Draft Version 1.1*

<u>Numerical Reference</u>			<u>Topic</u>
1.0			AIRFIELD & LAUNCH OPERATIONS
	<b>1.1</b>		<b>Operational Infrastructure &amp; Activities</b>
		1.1.1	Runways
		1.1.2	Terminal Facilities
		1.1.3	ARFF Facilities
		1.1.4	Hazardous Materials Storage & Transfer Facilities
		1.1.5	Aircraft/Spacecraft Tie-Down Areas
		1.1.6	Hangar Facilities
		1.1.7	Mission Control Facilities
		1.1.8	Launch Control Facilities
		1.1.8.1	Launch Pad Safety
		1.1.8.2	Maintenance of Ground-Based Launch and Flight Safety Systems
		1.1.9	Spaceflight Preparation Facilities
	<b>1.2</b>		<b>Ground Operations and Services</b>
		1.2.1	Motor Vehicle Operations
		1.2.1.1	Automobiles and Buses
		1.2.1.2	On-site Support Vehicles
		1.2.2	Fueling & Propellant Operations
		1.2.3	Maintenance and Repair Activities
		1.2.4	Construction Activities
		1.2.5	De-Icing Activities
		1.2.6	Meteorology
	<b>1.3</b>		<b>Flight Operations and Services</b>
		1.3.1	Communications, Navigation & Surveillance
		1.3.2	Conventional Aircraft Operations at Launch Sites
		1.3.3	Launch Vehicle and Passenger Return
		1.3.4	Payload Preparation/Assembly
		1.3.5	Spaceflight Participant Preparation
		1.3.6	Air & Space Traffic Management
2.0			SITE SECURITY
	<b>2.1</b>		<b>Security Policy</b>
	<b>2.2</b>		<b>Fencing and Barriers</b>
		2.2.1	Monitoring and Repair
		2.2.2	Animal Control
		2.2.3	Roadblocks
	<b>2.3</b>		<b>Spaceport Access</b>
		2.3.1	Personal Vehicles
		2.3.2	Delivery Control
		2.3.3	Media
		2.3.4	Visitor Shuttles
		2.3.5	Suspicious Vehicle Behavior
		2.3.6	Aircraft Access
		2.3.6.1	Emergency Aircraft Landings

Numerical Reference			Topic
		2.3.6.2	Security Screening
<b>2.4</b>			<b>Restricted Area Access</b>
	2.4.1		Onsite Personnel
	2.4.2		Passengers
	2.4.3		VIP Visitors
	2.4.4		General Public
	2.4.5		International Passengers and Visitors
	2.4.6		Media
	2.4.7		Launch Operator Responsibilities for Facility Security
	2.4.8		Spaceport Responsibilities for Site Security
<b>2.5</b>			<b>Security Systems</b>
	2.5.1		Cameras and Video Monitoring
	2.5.2		Alarms
	2.5.3		Security Patrol
	2.5.4		Access Logs
	2.5.5		Security Lighting
	2.5.6		Identification and Access Badge Procedures
3.0			EMERGENCY RESPONSE
<b>3.1</b>			<b>Law Enforcement</b>
	3.1.1		On-Site Law Enforcement
	3.1.2		External Support
<b>3.2</b>			<b>Aircraft Rescue and Firefighting (ARFF)</b>
	3.2.1		Firefighting
	3.2.2		Accident/Spill Response
	3.2.3		ARFF Compliance
	3.2.4		Rescue Vehicles
	3.2.5		Training
	3.2.6		Mutual Aid Agreements
<b>3.3</b>			<b>Medical Services</b>
	3.3.1		On-site Medical Facility
	3.3.2		Off-site Considerations
	3.3.3		Medical Emergencies
<b>3.4</b>			<b>Evacuation</b>
<b>3.5</b>			<b>Communications in the Event of an Emergency</b>
<b>3.6</b>			<b>Natural Disaster Response</b>
<b>3.7</b>			<b>Bomb Threats</b>
4.0			VISITOR MANAGEMENT
<b>4.1</b>			<b>Visitor Management Policy</b>
<b>4.2</b>			<b>On-site Visitor Accommodations &amp; Services</b>
<b>4.2</b>			<b>VIP &amp; Special Events</b>
5.0			GROUND AND FLIGHT SAFETY
<b>5.1</b>			<b>Safety Policy</b>
<b>5.2</b>			<b>Safety Management System</b>
	5.2.1		Safety Risk Management
	5.2.2		Safety Promotion

Numerical Reference			Topic
	5.2.3		Safety Assurance
<b>5.3</b>			<b>Ground Safety</b>
	5.3.1		Runway Safety
	5.3.2		Safety of the General Public
		5.3.2.1	Encroachment by Neighboring Property Owners
	5.3.3		Motor Vehicle Safety
	5.3.4		Fuel Safety
	5.3.5		FAA Launch Site License Requirements
<b>5.4</b>			<b>Flight Safety</b>
	5.4.1		Mission Planning & Flight Analysis
		5.4.1.1	Development and Coordination of the Mission Plan
		5.4.1.2	Air Traffic Coordination
6.0			ENVIRONMENTAL MANAGEMENT
	<b>6.1</b>		<b>Environmental Management Policy</b>
	<b>6.2</b>		<b>Environmental Permitting</b>
	<b>6.3</b>		<b>Historical, Architectural, Archeological, and Cultural Resources</b>
	<b>6.4</b>		<b>Noise Management</b>
	<b>6.5</b>		<b>Water Quality</b>
	<b>6.6</b>		<b>Air Quality</b>
	<b>6.7</b>		<b>Wildlife Management</b>
	<b>6.8</b>		<b>Hazardous Material, Waste, and Substance</b>
	6.8.1		Definitions
	6.8.2		Regulatory Environment
	6.8.3		Hazardous Material Contamination/Spills
	6.8.4		Fuel/Propellant Operations
	6.8.5		Explosives Site Planning
	6.8.6		Training Requirements
	6.8.7		Storage & Handling Requirements
	6.8.8		Record Keeping Requirements
	6.8.9		Hazardous Materials and Visitor Safety
	<b>6.9</b>		<b>Waste Management</b>
7.0			MISSION READINESS
	<b>7.1</b>		<b>Outside US Airspace</b>
	<b>7.2</b>		<b>Communications</b>
	<b>7.3</b>		<b>Safety</b>
	<b>7.4</b>		<b>Liability</b>
8.0			ITAR REQUIREMENTS
	<b>8.1</b>		<b>Impact of ITAR on Spaceport Operations</b>
	<b>8.2</b>		<b>Compliance requirements</b>
	8.2.1		Commodity Classification
	8.2.2		Internal Controls
	8.2.3		External Controls
	8.2.4		Risk Assessment
9.0			INTERNATIONAL COORDINATION AMONG SPACEPORTS

Numerical Reference		Topic
	<b>9.1</b>	<b>Communication</b>
	<b>9.2</b>	<b>FAA/CAA Coordination</b>
	<b>9.3</b>	<b>Passenger manifests</b>
	<b>9.4</b>	<b>Immigration</b>
	<b>9.5</b>	<b>Customs/Duty</b>
10.0		SELF-INSPECTION
	<b>10.1</b>	<b>Operations</b>
	<b>10.2</b>	<b>Security</b>
	<b>10.3</b>	<b>Safety</b>
	<b>10.4</b>	<b>Compliance</b>