

Research Roadmap Workshop Summary Document

Executive Summary

The FAA Center of Excellence for Commercial Space Transportation (FAA COE-CST) Roadmap Meeting for Topic 1.2B-Spaceport Operations was held on November 17, 2014. Industry leaders and community stakeholders attended the meeting in person and by conference call. Because of the National Transportation Safety Board (NTSB) investigation resulting from the accident at Mojave Air and Spaceport (see Appendix A-NTSB Investigation Party Form) some members of the community were not able to attend. [Note-on October 28, 2014, there was an accident destroying Orbital Sciences Corporation's Antares rocket and the company's unmanned Cygnus Spacecraft at the Mid-Atlantic Regional Spaceport. On October 31, 2014, there was a fatal accident involving Virgin Galactic's SpaceShip Two at the Mojave Air and Spaceport.]

Design of this Roadmap Workshop

Seven questions for discussion were prepared by Pat Hynes and sent to the participants and other members of the community. Below are the final questions examined by the assembled group. The meeting was recorded.

List of Participants

Herb Bachner	Consultant, HBachner and Associates LLC
Joe Bullington	Director, Mission Services Department at Jacobs Technology, NASA White Sands Test Facility
Scott Colloredo	Director, Center Planning and Development Directorate at NASA's John F. Kennedy Space Center in Florida
Billy Garrett	Commissioner, Dona Ana County, NM
Jim Hayhoe	President, Spaceport America Consultants, LLC
Diane Howard	Assistant Professor, Commercial Space Operations at Embry-Riddle Aeronautical University
Chuck Hunsaker	President and CEO, Winged Foot Consulting
Pat Hynes, Convener	Director, New Mexico Space Grant Consortium and NASA EPSCoR, Core Member, FAA COE-CST

Vicki Johnston	Chief, Partnership Development at NASA
Eddie Kennedy	Executive Officer at US Department of Defense, White Sands Missile Range
Norice Lee	Associate Dean of the Library, New Mexico State University
Christine Logan	Community, Business and Rural Development Representative, New Mexico Economic Development Department
Rene Rey	Senior Aerospace Engineer, FAA AST
Jeff Roberts	Lead Engineer, Alaska Aerospace Corporation

FAA AST Research Theme: 1.2B Spaceport Operations.

Related Research Themes

Suborbital Vehicles (2.2, 2.3) are relevant to spaceport operations under coordination between the launch operator and the launch site operator required by FAA Regulations Part 417: Launch Safety. The information we provide under 1. Space Traffic Management and Operations and 1.4 Spaceport Operations is closely related to 2. Space Transportation Operations, Technologies and Payloads; 2.2. Vehicle Safety Analyses; 2.3. Vehicle Safety Systems and Technologies; and 2.5. Vehicle Operations Safety, please see FAA regulations Part 420: License to Operate a Launch Site. A limitation of our roadmap study may be that we are not doing spaceports and vehicles together now.

The research theme is related to the FAA statutory goal of protecting public health and safety as well as encouraging private sector launches and related services.

Participant Discussion

Discussion Topic No. 1

Regarding the agreements and relationships between spaceport and launch operators: The difference between what is public information and IP is especially critical in the areas of spaceport operations, procedures and policies. Why? As the uninvolved public, taxpayers, investors examine whether they want to invest in the commercial space transportation industry, good information and transparency are going to become more important. Any guidance for the FAA on this will be useful. Is the current status good for industry going forward?

Industry leaders and community stakeholders in attendance at this roadmap meeting examined how the FAA regards the spaceport operator and the individual launch operator. Most of the operations responsibility falls on the launch operator. The FAA asserts control over the launch site/spaceport operator. The spaceport operator is responsible for topics related to individual characteristics of the spaceport and its location. For example, a spaceport could be contiguous to a federal launch range or a commercial airport; it could have both vertical and horizontal launch facilities or only vertical launch facilities. It could be an inland, land locked, or coastal spaceport. At the time of this meeting, there are nine FAA licensed commercial spaceports. The relationship between the launch operator and the spaceport operator is dictated by FAA regulations covered in Part 420: License to Operate a Launch Site.

Regarding public information and current status of the industry going forward, it is useful to discuss indemnification (Commercial Space Launch Act (CSLA) 2004: House Committee on Science, Space and Technology: Feb. 4 hearing. Rep. Donna F. Edwards. “Members and witnesses discussed a number of questions including, shared-liability indemnification and how the Maximum Probable Loss (MPL) is calculated; the dual role FAA has as advocate and regulator of the commercial space industry and whether this causes a conflict of interest; how the investigation of a commercial space launch accident would be handled and what agencies would handle it; if the “informed consent” approach space operators currently use to inform participants of the risks of launch and reentry is adequate; and whether there are viable alternatives to the current shared-liability indemnification program such as shifting to an insurance pool approach that should be considered as Congress looks to the future of this industry. “[T]he recently passed extension of the third-party liability and indemnification regime for three years means that we have the time for a thoughtful examination of these questions, and I look forward to our Subcommittee conducting future hearings to address them.””).

In October of 2014, some of the concerns mentioned above are now being addressed as the investigation related to the accidents at MARS and Mojave unfold. It is generally accepted at the time of this report neither spaceports contributed to the causes of the accidents. Yet, it is important to understand their roles as the accident investigations evolve and the public information continues to come out.

The site operator is a subcontractor of the launch operator. The launch operator must show that they are financially responsible for the maximum probable loss and, above that maximum probable loss, the US government can indemnify. The site operator does not go through a financial responsibility review because the site operator is not indemnified by the U.S. government. It’s hard to come up with something that is always going to be the case because there isn’t something that is always the case. What there is instead is the FAA asserts a certain amount of control over the spaceport operator and a whole lot more control over the launch operator.

Regarding emergency response, each launch site or spaceport has a different emergency response capability. A spaceport located close to a metropolis or a military base might have access to more emergency response than a site that is geographically remote. Some launch operators might negotiate added emergency response capability for certain operations taking place at a spaceport. Currently, the negotiated agreements between launch operators and site operators are considered proprietary and not in the public domain, not unusual for commercial activity. In fact, there is a fairly significant gap between what is public information and what is locked into the IP under the various spaceport to launch operator agreements.

Looking at this issue from the perspective of the recent accidents and MARS and Mojave, the industry leaders have noted that the indemnification scheme is set up to benefit third parties, e.g. someone hit by debris on the ground; it is not designed for the benefit of the crew or pilots.

Discussion Topic No. 2

Regarding emergency response and communications with media in light of the recent accidents at Mid Atlantic Regional Spaceport and Mojave Air and Space Port: How did the two spaceports, launch operators and their related support community do when two accidents occurred in 1 week?

Industry leaders and community stakeholders in attendance at this roadmap meeting observed that most emergency management plans have a component that has to do with media relations. It is important for the respective organizations to evaluate themselves on how they handled communications following these accidents. We can learn from their experiences: where there might have been holes and gaps. Under FAA regulations Part 420: License to Operate a Launch Site, within five days, the spaceport operator must submit a report on the spaceport accident.

There is no reason that the communication process has to be any different than airport incidents. Nevertheless, the issue of safety with an emerging technology is very critical. The FAA has a very good reputation for its thorough investigations and its investigations help provide credibility to the industry. The interface between the FAA and the industry is important in helping to put an accident in context for the flying public and for improving or closing any gaps uncovered in emergency response.

Discussion Topic No. 3

Do we understand the impact of these 2 accidents on the FAA AST yet? Do we see regulations that may emerge because of these accidents? In both cases, it does not appear the spaceports were involved in the causes of either accident. Agree/Disagree/Too early to know.

Industry leaders and community stakeholders in attendance at this roadmap meeting noted that the NTSB investigations will likely focus on the technical reasons behind the accident at Mojave Air and Space Port, but it will also review the safety culture and processes of the companies involved in developing the launch vehicles as well as the safety culture of FAA AST. The NTSB is leading the Virgin Galactic investigation and will dig down for the root cause of the accident and that will take some time. Only after that, will the topic of new FAA regulations even be considered. The FAA can only wait and see. Orbital Sciences is leading the investigation into the accident at Mid-Atlantic Regional Spaceport.

Even though the site operator and the launch operator are separate when it comes to IP, in the event of any accident, the facility is always going to be involved regardless of the operator because the facility provides the infrastructure and the accident response. While there is a push to keep the two separate, there is also a need to coordinate how the two entities work together both during and after any accident. Whether this coordination requires FAA regulation is yet to be seen.

As far as the NTSB is concerned, they are an independent body. They have broad and great power to get the information they need. They identify the cause and they make recommendations on how to fix the problem. As the regulatory agency, the FAA can follow the NTSB recommendations but it is not required to do so. Based on one accident alone, the FAA would only have the authority to write a regulation that's specifically narrowly tailored to correct the problem that the NTSB identified. It is not expected that broad, sweeping regulations would come out of the recent accidents.

Discussion Topic No. 4

Regarding Research and Development Activities vs Commercial Operations: The Experimental Launch License does not cover those crew or spaceflight participants on board. Commercial Space Launch Amendment does not indemnify any spaceflight participants. So, the next tier of people we will engage will be the insurance companies. Anyone have comment here?

Industry leaders and community stakeholders in attendance at this roadmap meeting observed that the launch operator can have an operator's license even though the vehicle is not certificated for air worthiness. Insurance companies are not likely to insure a vehicle prior to the air worthiness certification. There might be a market that would cover these vehicles but it would be it would be incredibly expensive.

One participant noted that he has asked those in the insurance industry about their ability to provide insurance to Reusable Launch Vehicles (RLV) and was told that it would be difficult for

them to support an industry where one accident or a major accident could put the insurance company out of business. Therefore, they said, for insurance purposes these vehicles will fall into will be a much larger group of transportation vehicles that typically have insurance called "hull insurance" i.e. insurance protecting the owners against loss caused by damage or destruction of waterborne craft or aircraft. The insurance industry would not create a separate category for reusable launch vehicles but include new launch vehicles within the parameters of current hull insurance.

The current informed consent regulations are contained in Part 460: Human Spaceflight Requirements; this licensing regime essentially provides that space flight participants fly at their own risk. Individual states, like NM, California and Virginia, have passed laws insulating the spaceport operator from liability.

There are already companies that are offering insurance for space tourists: personal accident insurance. It was observed that once there is insurance and lawyers involved, everyone tends to get tight lipped.

One of the participants wanted to make the point that spaceflight participants will have many reasons for flying as private citizens, not just thrill seekers but also researchers and investigators preparing for the larger exploration missions. Insurance companies are already moving away from being perceived as only space tourism insurers. See Appendix B- "Spacesuit? Helmet? Life insurance? Space tourist loophole may end."

Discussion Topic No. 5

Question posed to this group: What does the industry envision a spaceport to be?

Industry leaders and community stakeholders in attendance at this roadmap meeting noted that a spaceport is a commercial endeavor that must provide a return on investment. To make it commercial, it has to diversify as much as possible and there must be as much use and access of the facility as possible. Some believe that a spaceport should feel like an airport in the way it is used and commercial operations. While the primary business might be to launch rockets and/or spacecraft, a spaceport should diversify in a way that does not interfere with its primary business.

Some believe that a spaceport will be in the business of point-to-point transportation and, therefore, part of a network of spaceports. There must be inclusion of spaceports into a whole transportation system.

Connected with that could be retail, business centers, restaurants and dining: viable commercial activity that links up to other commercial activities in the area as happens now at commercial

airports. This is also challenge for inland spaceports because of the risk of launching rockets and the need for large separation distances in the event of an accident. From a risk management standpoint and from a noise standpoint, ideally, the spaceport should be isolated.

Attendees observed that there should be interoperability among spaceports. Eventually, spaceflight will be point-to-point and spaceports are going to have to evolve into entities more like airports. You land and take off at one, get fully serviced and land at another one. Airports range everywhere from simple grass strips with no supporting buildings, like maybe a barn at the other end. Then you have the fully equipped airports with towers and ground control. Spaceports might fall somewhere in between those two ranges but to be viable they are going to have to be interoperable.

One challenge in the evolution of point-to-point spaceflight is providing fuel and servicing at each spaceport because right now there are different kinds of spacecraft with different configurations and different fuels. Another challenge is getting these spacecraft off of the United States Munitions List (USML) and onto the Commerce Control List (CCL).

Discussion Topic No. 6

What else might they be doing to encourage, facilitate, and promote the industry? These are unique functions for the FAA AST Division.

Industry leaders and community stakeholders in attendance at this roadmap meeting discussed the development of industry intensive standards that could work in tandem with the recommended practices of the FAA. This would allow the industry to be a stakeholder and co-creator of what might eventually be FAA issued regulations.

Attendees also discussed modifying the Commercial Space Launch Act (CSLA) 2004 to require cost accounting standards for those who are using federal subsidized ranges. This would address what some perceive as unfair advantages for federal ranges over commercial or private spaceports. But the intent of the CSLA must be considered and there are also things that can be offered to partners under the CSLA that are not competitive with private launch sites. Within this discussion is the idea that transparency will help everyone understand that federal ranges sometimes have capability and infrastructure that is essential to a launch. Yet under the 2010 National Space Policy and the 2013 National Space Transportation Policy, when a launch can occur on a commercial spaceport, the federal ranges are not to compete. This is a long standing guideline or regulations for the federal laboratories as well. They are not supposed to compete with industry where there is a commercial product available. Transparency allows commercial customers to know what they are getting should they compare the costs and benefits of using federal ranges or commercial spaceports.

Discussion Topic No. 7

When do we think the FAA's role will evolve beyond what it currently is?

This topic was covered under Discussion Topic Nos. 3 and 6.

Research Projects that Support the Research Theme

The research theme of spaceports must be approached from the perspective of the FAA statutory goal of protecting public health and safety as well as encouraging private sector launches and related services.

In the next 5 years more launch operators will be flying under commercial licenses at commercially licensed spaceports. In the case of sub-orbital vehicles, there are only a few operating right now, none under a commercial license.

FAA regulation Part 417.9: Launch Site Responsibility provides:

For a launch from a spaceport licensed under Part 420 of this chapter, a launch operator [vehicle operator] must:

- 1) Conduct its operations as required by any agreements that the launch site operator [spaceport] has with any Federal and local authorities under part 420 of this chapter; and
- 2) Coordinate with the launch site operator and provide any information on its activities and potential hazards necessary for the launch operator, person, or property at the launch site as required by the launch site operator's obligations under 420.55 of this chapter.

Currently, all correspondence, agreements and procedures between launch operators and sites is held privately by the parties, not publically disclosed. It is evident that there is a real gap in the knowledge of how launch operators and site operators interact and this gap is exacerbated by the divergent paths of research that have been allowed to continue within the FAA COE CST theme hierarchy. In order to move forward, the interaction between ground operators and vehicle operators must be studied as a whole and these groups must come together to discuss what they see as milestones that need to be addressed, each cohort making their contributions in relationship to the other.

We previously assembled the Body of Knowledge for Spaceport Operations and established a related Framework for Spaceport Operations (Appendix C). As of December 2012, we have interviewed all commercial spaceport Directors and asked them to contribute to the Body of Knowledge. A Content Management System (CMS) was developed for the Body of Knowledge,

and we presented the completed Body of Knowledge and Framework and sought input from spaceport directors and other users on the ease of use, searchability and relevance of the categories we established. We have presented the Framework to others in the industry and government including members of the Range Commanders Council, COMSTAC Operations group, FAA managers, Airports organizations, foreign visitors and will present this September, to the International Astronautical Congress. This data base consists of many hundreds of pages of documents, and related website links to thousands of pages of related documents. The database can be accessed here: <http://contentdm.nmsu.edu/>

Project No. 1-Relating to Discussion Topic Nos. 1, 2 and 3

Participants in the roadmap meeting noted that the framework for the Body of Knowledge for Spaceport Operations contains a gap and does not address emergency response and communications in the event of an incident at a spaceport involving a launch operator. From the perspective of the FAA statutory goal of protecting public health and safety as well as encouraging private sector launches and related services, a worthwhile project would be to provide guidance to spaceport operators and launch operators on emergency response and communications in the event of an incident. Further justification for this project is found in the 2013 National Space Transportation Policy which contains this guideline: “Facilitate U.S. commercial industry access to available public data and lessons learned related to human spaceflight.”

The tasks that can be undertaken within the project of providing emergency response and communication guidance to site operators and launch operators would be to (1) locate documents, in particular-NTSB guidelines and when reports become available integrate findings into the digital collection- and develop information to fill this gap; (2) continuously update the digital collection. The first and second task would be beneficial to the community in the short term and should be undertaken as soon as possible. With the recent incidents at MARS and Mojave, the public and the industry deserve to have this information developed now, before any additional incidents take place. This would serve to restore public confidence in the industry during this vulnerable period when public opinion might shift away from support.

Project No. 2-Relating to Discussion Topic Nos. 1 and 4

The Body of Knowledge framework contains Section 7.4 Liability – Insurance and cross waivers. This is an area that could be expanded and developed with additional research. Insurance and waivers are a very complex topic that affects everyone involved in the industry. There are different types of insurance covering different entities for different purposes. In addition, there are waivers that are required by law as well as statutory created immunities in

several instances. In order to promote the stated goal of encouraging private sector launches and related services, it would be beneficial to provide more information to the evolving commercial space industry.

The tasks that would be undertaken would be (1) search for documents, rules and regulations pertaining to this topic and (2) populate the Body of Knowledge digital collection. The first and second task would be beneficial to the community in the short term and should be undertaken as soon as possible. The incidents at MARS and Mojave have caused these questions to come to the forefront of discussions taking place in the media and in the industry. This would serve to restore public confidence in the industry during this vulnerable period when public opinion might shift away from support.

Project No. 3-Relating to All Discussion Topics

As we have already developed a framework of 10 major categories with a total of 124 sub categories, our team suggested that we query the people that are using the online Spaceport Operations data base to tell us where there are information gaps that they would like to see filled and their proposed priorities. We expect to survey people who come to the web site online using the NMSU Content Management System data base and a Survey Monkey tool. The NMSU Library would be tasked to attach the survey monkey tool with the Space Operations Framework and gather the responses from the survey monkey. This information would allow us to setup a roadmap for further expansion of the framework based on the survey of subject matter areas that needs to be expanded and the user's priorities.

There are 4 different groups who use or could use our database and from whom we would obtain information on the areas that need to be expanded and their priority. These include:

1. Spaceport Executive Directors and their operations personnel
2. Airport/Spaceport Developers and their associations of members that anticipate applying for a license (America Association of Airport Executives, the Airports Consultants Council have been briefed as well as the Commercial Spaceflight Federation and COMSTAC.)
3. Launch vehicle operators, educators, researchers who want to know what a spaceport is and what does it do.
4. State and Federal officials and their agencies that need to know about spaceport operations and how it may impact their activities. (e.g. Department of Interior/Bureau of Land Management, State Aviation Departments, State Economic Development organizations, DOD/Air Force, NASA, FCC, and the Commerce Department). Spaceports are currently a growth industry.

The project would consist of five tasks:

1. Development the survey.

2. Promotion to people to take the survey.
3. Time of librarian and technical staff to work the survey into the website.
4. Team members to analyze the survey.
5. Write up final results report.

As stated, this survey methodology would identify areas of weakness and strength within the Framework. Those areas of the Framework that are populated with a good number of relevant documents, advisories, circulars will not need much work. Those areas of spaceport operations that are not well populated with documents, or which have no documents will be identified quickly through the use of the survey monkey. Finally, the users of the content management system will have input to determine the priorities of categories that need additional research.

Project No. 4-Relating to All Discussion Topics

From the perspective of the FAA statutory goal of protecting public health and safety as well as encouraging private sector launches and related services, a worthwhile project would be to encourage more transparency in the agreements that exist between spaceports and launch operators.

There would be four tasks that would be part of this project:

1. Develop and administer confidential anonymous surveys to spaceport operators and launch operators. The purpose of the surveys would be to allow these entities to share some of the basic provisions in their agreements without jeopardizing their intellectual property or commercial competitive advantage.
2. The information would then be converted to summary form so that the identity of those participating would not be revealed.
3. Search for documents, rules and regulations pertaining to this topic.
4. Populate the Body of Knowledge digital collection.

This project should be a medium to long term goal for the FAA. It will benefit the industry because many individuals are currently required to make decisions about which spaceport they will use and transparency will serve to inform those decisions. In addition, those entities that are considering investing in the industry will have more confidence in their investments going forward.