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Technical Paper Session II - Training a Suborbital Flight Crew

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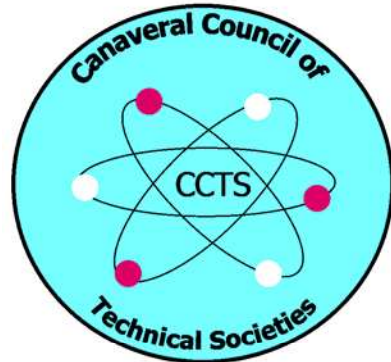
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SPACE VISIONS CONGRESS 2007

TECHNICAL PAPER
SESSION 2
“TRAINING A SUBORBITAL FLIGHT CREW”
BRYAN ATHAN



Training a Suborbital Flight Crew

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Abstract

This paper will look at current requirements already set in place by the Federal Aviation Administration (FAA/AST) for suborbital flight crew and spaceflight participant training, as well as reflect on direct personal discussions with the FAA/AST that specifically relate to training.

1. Introduction

In 2004 the barrier to private commercial space (hereafter referred to as “New Space” – the industry adopted title) was breached by the successful flight of Spaceship One into suborbital space. The doors were then opened by the passage of the 2004 CSLAA (Commercial Space Launch Amendment Act). The combination of these two events has ushered in a new age of spaceflight.

There are now several entrepreneurial companies in various stages of vehicle development, construction, and testing, with

civilian “space tourist” flights expected to begin as early as 2008. With such highly visible companies like Virgin Galactic rocketing six passengers and two crewmembers on a one to two hour journey into space and back, it’s easy to predict that this new industry will soon become a very lucrative one for those providing this service, especially with an initial ticket price is \$200k per person per flight.

A necessary part of the New Space industry will be a vast infrastructure to support it as it moves from suborbital, to orbital and beyond. As it is in the Aviation industry, training will be an integral part of “New Space” to insure the safety of the participants as well as the general public.

The FAA/AST is diligently working with companies involved in the New Space industry and is eager to accommodate these companies within all legal boundaries covered in US CODE Title 49, ch.701 (*Commercial Space Launch Activities*). This paper takes a look at some of the

similarities and differences between training for the Aviation and “New Space” industries.

2. The Necessity of Training

- **Legal framework (History of AST)**

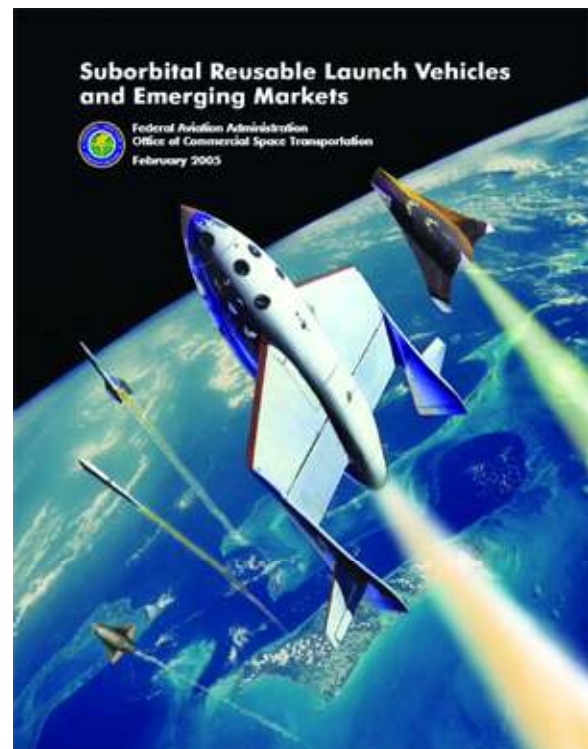
The AST receives their authority through **Title 49 U.S. Code, Subtitle IX, Section 70103. General Authority.** Those are the statutes instituted by Congress and adopted by the FAA/AST as the regulations pertaining to suborbital flights where civilians are concerned.

“The Office of Commercial Space Transportation (AST) is the only space-related line of business within the Federal Aviation Administration (FAA). Established in 1984 as the Office of Commercial Space Transportation (OCST) in the Department of Transportation (DOT), AST was transferred to the FAA in November 1995.

The Office of Commercial Space Transportation (AST):

- Regulates the commercial space transportation industry, only to the extent necessary, to ensure compliance with international obligations of the United States and to protect the public health and safety, safety of property, and national security and foreign policy interest of the United States;
- Encourages, facilitates, and promotes commercial space launches and re-entries by the private sector;

- Recommends appropriate changes in Federal statutes, treaties, regulations, policies, plans, and procedures; and
- Facilitates the strengthening and expansion of the United States space transportation infrastructure.”¹



- **Orbital Commerce Project, Inc.**

OCP was incorporated in 2004, and is the first private “New Space” flight training company to enter the market. OCP has been very active in working with the FAA/AST in attempting to formulate reasonable regulations for training that take into account the issues of safety. The framework for these regulations is based on statutes already passed into law by

1

http://www.faa.gov/about/office_org/headquarters_offices/ast/about/

Congress (U.S. Code Title 49).



- **How Title 49 Affects Training**

In the “New Space” industry there are presently two classifications of spaceflight personnel: the “flight crew” and the “flight participants”. The term “flight crew” refers to the pilot, payload specialist, remote operator, carrier aircraft crew, cabin crew, and anyone else involved in the operation of the vehicle. A “spaceflight participant” is a “paying” passenger that takes no part in the operation of the vehicle and is simply along for the ride. Paying passengers are expressly forbidden to touch the controls

For a person to be able to be fully trained as a suborbital pilot by a flight school they must be an employee or contractor of an operator and the operator must contract with the school.

So where is the problem? The dilemma is this: according to OCP field research conducted in 2006, from the respondents we polled that would like to pilot a suborbital vehicle, 90% of those pre-qualified to do so

have no intentions of ever becoming a commercial space pilot. Just as in the aviation realm not every private pilot flies for a commercial airline.

The larger market that would allow a school to fully train suborbital pilots and thrive has been disallowed by the statute. With only the remaining 10% of those interested in flying as commercial space pilots allowed to be hired and trained beyond mere simulation training, it is my belief that there would not be enough students to sustain a spaceflight training school. If true, this prospect would leave the training burden entirely on the backs of the vehicle operator(s) which may not necessarily be the best option. That would appear to be at least minimally contrary to the 2004 CSLAA which prohibits the stifling of this new industry and *is* contrary to standard practice in the aviation industry training realm. In this author’s opinion, this is neither the most efficient, nor the safest policy.

If the number of annual spaceflights is anywhere near those projected by the Associate Administrator for Commercial Space Transportation (AST), Patti Grace Smith; *“We are preparing for the day when commercial space is as common as air travel.”*; and Chairman of the X-Prize Foundation, Dr. Peter Diamandis; *“We need a vibrant marketplace that will allow for hundreds or thousands of flights per year. This will only come as we develop and*

promote the personal spaceflight market.”², there will be a great need for a new category of “student pilot” which would require an amendment to Title 49 allowing a third party training school to train independently of the operators and on a pay to learn basis. One way to institute this change is through an industry group association of “New Space” business’ that would lobby Congress for an amendment to the statute. This would be needed before a truly viable and comprehensive training school can be brought into existence. OCP



is currently spearheading an effort to create just such association.

- **Life Safety Issues**

The term “Life Safety” is one that I adopted from personal experience in the Fire Alarm industry. The Life Safety Code is the list of fire codes set by the National Fire Protection Association (NFPA) and adopted by Fire Marshals across the U.S. for safety

² Article entitled: “How Safe Is the Race To Send Tourists into Space?” published in the April 19th 2007 edition of the Wall Street Journal

and welfare of the general public. In this instance, my definition for “Life Safety” with respect to the “New Space” industry encompasses the systems or mechanisms in place to ensure the safety of spaceflight crewmembers, passengers and innocent bystanders to the fullest extent possible.

Space is a very risky business. This has been said many times. Therefore, the greatest concern surrounding the “New Space” industry is one of safety. In the event of an emergency situation, the spacecraft must be piloted in such a way as to remove the possibility of a catastrophic incident involving the general public. If one of these vehicles were to collide with a McDonalds or a Wal Mart, the potential loss of innocent life would undoubtedly do serious harm to the operator, and quite probably the private space industry as a whole. Therefore, every precaution must to be taken to minimize the possibility of such a disaster. Proper training is the keystone to safety.



Unlike the Aviation Industry, the highest priority is the bystander on the ground that had no say in the flight with the second highest priority being the safety of the passengers and crew. Those flying as

passengers and crew in the vehicle would have previously been meticulously instructed about the risks involved, and required by statute to sign an “Informed Consent” form prior to their flight stating that what they are about to do is voluntary and they have a full understanding of all the risks involved and that the United States Government has not certified the launch vehicle and any reentry vehicle as safe for carrying crew or spaceflight participants.

- **Flight Profiles**

Civilian space vehicles may incorporate different means of propulsion, flight, and landing, all during a single flight. These will likely include some or all of the following: jet engines for maximum altitude ascent prior to rocket engine ignition, rocket powered near vertical flight, Reaction Control Systems (RCS), proper atmospheric reentry orientation, powered or un-powered flight and touchdown.

These systems can range from the two-tiered system as used by Scaled Composites with White Knight / Spaceship One, to a more conventional horizontal takeoff and vertical ascent with horizontal touch down, to a Vertical Takeoff and Landing (VTOL) type system. Even NASA style rocket launch and capsule recovery system is not outside the realm of possibility.



Because of the multiple systems necessary to venture into space and return safely, there will be a need to train proficiency in all of those systems.

OCP will be instructing spaceflight trainees on piston driven versions of the training vehicle to acquaint pilots with the handling characteristics of its vehicle during un-powered flight and landings, rocket powered high altitude vehicles for rocket engine control, and suborbital vehicles for training in actual space flight technologies.

- **Crew Requirements**

“Each member of a crew must complete training on how to carry out his or her role on board or on the ground so that the vehicle will not harm the public.”³

Additionally, 14CFR part 67-9 requires each crewmember with a safety-critical role possess and carry a FAA Second-class Airman Medical Certificate.

The crew training provided by OCP will be virtually the same for pilots and crew, with

³ NPRM, subsection 460.5(a)(1)

the exception that crew members will not be permitted to touch the flight controls in an actual flight, except in the case of an extreme emergency where the pilot is incapacitated and can no longer pilot the vehicle safely.

- **Pilot Training**

Pilots, and/or remote operators must be at least 18 years of age, possess and carry an FAA pilot certificate with an instrument rating, possess experience, and the skills necessary to control the launch or reentry vehicle. Experience may include hours in flight, ratings, and training. In addition, pilots and/or remote operators must obtain vehicle, and mission-specific instruction through one or more of the following methods; a simulator or other device that replicates the flight scenario, actual flight in a vehicle with the same flight characteristics as the mission vehicle, performing flight tests of the actual vehicle, or through an as of yet non-existent training method when approved by the FAA.

Since these are the minimum requirements, OCP will be adding to these requirements; training in both a hypobaric chamber for high altitude training, and a centrifuge for 'g' tolerance function testing, thereby further diminishing the possibility of an accident. Due to the intensity and pace of training, the courses offered by OCP will be based on a

disciplined regime for a minimum amount of distraction. There will also be a hierarchical system for different levels of trainees based on qualifications and the specific training they are receiving.

- **Classroom Training**

Classroom training should be intense, with as few distractions as possible, and always focus on safety first. All aspects of the flight profile must be covered, including (but not limited to) rocket engine theory, reaction control system, egress (emergency, or other), reentry, glide path, and un-powered landing.

- **Simulation**

Flight simulation training for a suborbital vehicle is an invaluable tool as is true with all of aviation. Many of the characteristics of the vehicle can be learned before ever climbing into the cockpit.



OCP Flight Simulators

Simulation can be used to train for emergency situations that are impossible or to dangerous to replicate in the real world.

All types of failures, weather conditions and errors can be repeatedly reproduced allowing the student to become proficient without risk to life or equipment.

- **Passenger Training**

Spaceflight passengers will need to be trained; just as the airline industry briefs its passengers with a limited set of pre-flight instructions on what to do in case of an emergency. However, there will be a need to supply more training for those that wish to travel into space, especially where passengers are to be allowed to leave their seats and float in a microgravity environment for a very limited duration, and then being re-secured in their seats before experiencing the reentry 'g' forces.



It has been recommended by the FAA/AST that flight participants have a physical examination to determine if a passenger is fit for flight. Even though there are some conditions that can go undetected despite the level of examination, I believe this is a prudent course to follow as can be shown by the recent deaths that occurred at Disney's Mission Space ride due to

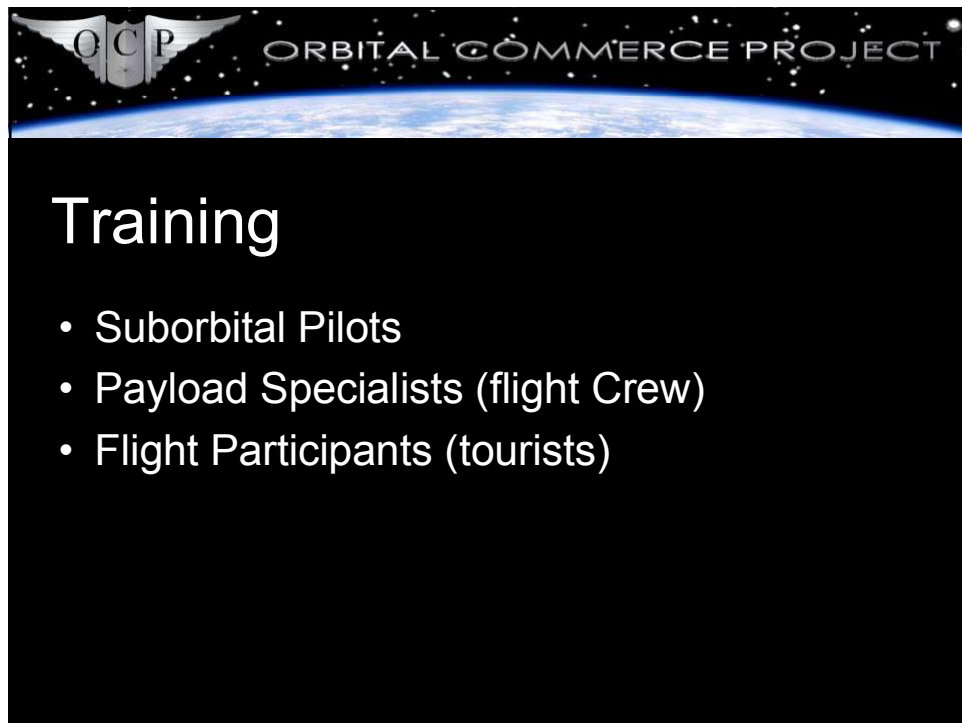
previously undiagnosed medical conditions. The Mission Space ride only reaches a maximum 2 'g's'. A suborbital space flight can potentially reach 5 'g's'.

- **Informed Consent**

As mentioned above, another requirement set forth by the Federal Regulations is a signed "Informed Consent" form. There is no general form. Instead, each operator will have to create his/her own form until, or unless, a blanket form is created and adopted by the industry or the FAA as a standard. The form must state that the crewmember or passenger will be fully aware that what they are about to do can be potentially fatal if something goes wrong, and should a mishap occur, the U.S. Government would be held harmless. It does not indemnify the operator against negligence or carelessness on the part of either the flight crew or the operator.

The State of Virginia recently passed an amendment (House Bill No. 3184)⁴ to the Code of Virginia that absolves operator liability through specific compliance with conditions in addition to the Title 49 "Informed Consent" requirements. This amendment will go into force on July 1, 2007 and sunset on July 1, 2013.

⁴ *The Code of Virginia, Chapter 3 of Title 8.01 article 24, sections 8.01-227.8 through 8.01-227.10*





Three phases of training for all disciplines

- Classroom
- Simulation
- Flight Time



Suborbital Pilot

- Classroom
 - Basic flight characteristics of vehicle
 - Emergency Procedures
 - Health Screening
 - Pressure Suit
 - Informed Consent Form



Suborbital Pilot

- Simulation
 - Nominal Flight Conditions
 - Non-nominal Flight Conditions
 - Centrifuge
 - Hypobaric Chamber
 - Fire and Smoke Control
 - Emergency Egress



Suborbital Pilot

- Flight Time
 - Three Different Vehicles
 - Un-powered Landing
 - Rocket Powered Ascent
 - Suborbital Control (RCS)





Flight Crew and Participants

- Subset of pilot course
- Less Time
- No Control of Vehicles



Benefits

- Standardize Skill Set
- Weed Out Unsuitable Candidates
- Lower Human Risk Factors
- Increase Enjoyment of Experience



Regulation Questions

- How to Certify:
 - School (Is the school defined as an RLV operator?)
 - Courses
 - Equipment
 - Graduates



Regulation Questions

- Market research shows that 90% of the people who would pay for the course will not work for an operator
- Current aviation schools turn out far more commercial graduates than jobs
- You do not have to work for an airline to get a commercial license



Review of Regulation Questions

- How to Certify:
 - School
 - Courses
 - Equipment
 - Graduates
- Permitting:
 - Training of Flight Participants
 - Flying Rocket Powered Aircraft at Air Shows
 - Flying Non-paying Passengers

