FAA
Commercial Space
Transportation

Sample Experimental Permit Application for a Vertical Launch and Landing Reusable Suborbital Rocket

Version 1.1

April 2007

Federal Aviation Administration
Commercial Space Transportation
800 Independence Avenue, SW, Room 331
Washington, DC 2059

NOTICE

Preface

The Purpose. This "Sample Experimental Permit Application for a Vertical Launch and Landing Reusable Suborbital Rocket" is an example of an application that allows the Federal Aviation Administration (FAA), Office of Commercial Space Transportation (AST) to initiate the reviews required to make an Experimental Permit determination. The approach described here provides one acceptable means to satisfy the requirements for an experimental permit application for a vertical launch and landing reusable suborbital rocket with a crew.

This Sample Experimental Permit Application does not set mandatory requirements and does not constitute a standard or regulation. We issue it to describe an acceptable means, but not the only means, for demonstrating compliance with Experimental Permit application requirements. Other approaches that fulfill regulatory objectives may be acceptable to the FAA's Office of Commercial Space Transportation.

The Background. An applicant seeking to conduct launches or reentries under an Experimental Permit must submit an application to the FAA's Office of Commercial Space Transportation. The FAA performs an initial screening or review of the application to determine if the information provided is "complete enough" to initiate the permit review process. We use Title 14 of the Code of Federal Regulations (14 CFR) part 437 Experimental Permits as a guide. After completing our initial review, we notify the applicant of the following:

1) The FAA accepts the application and will initiate the reviews and evaluations required to make a decision about the permit; or
2) The application is so incomplete or indefinite that the FAA cannot start to evaluate it.

Once the FAA accepts an application and determines that it is complete enough, we have 120 days to make a permit determination as to whether-or-not to issue an Experimental Permit to the applicant. If the application is not complete enough, we notify the applicant in writing that the application lacks enough information to complete the evaluations and approvals required for a permit determination, or that issues exist that would negatively affect a permit determination.

BlueSky Aerospace's Experimental Permit Application. The vehicle and concept of operations described in this sample permit application are those of a vertical launch and landing reusable suborbital rocket. Based on a hypothetical scenario, BlueSky Aerospace—a fictitious company—proposes to develop a reusable vertical launch and landing rocket to be flown for the purpose of research and development. BlueSky seeks an FAA Experimental Permit to conduct its research and development tests within an operating area located south of SpaceCity, MyState. This potential operator proposes a two-tiered development program: 1) The short-term goal is to conduct launches, under an Experimental Permit, to 40,000 ft (12 km) and 328,000 ft (100 km) with a crewed suborbital rocket; 2) The long-term goal is to develop an operational reusable suborbital launch vehicle capable of carrying one pilot and two paying passengers to an altitude of 100 km in order to experience about four minutes of zero gravity. BlueSky will seek a Launch License to operate this reusable suborbital launch vehicle. The following attachment demonstrates the submittals BlueSky should provide to the FAA as part of its application for an Experimental Permit.

Earnest J. Rocketman, Ph.D.
President and Chief Scientist
BlueSky Aerospace
123 Milky Way
SpaceCity, MyState 12345
September 12, 2006

Federal Aviation Administration
Associate Administrator for Commercial Space Transportation
Room 331
800 Independence Avenue, S.W.
Washington, D.C. 20591

Attention: Application Review

BlueSky Aerospace is pleased to submit the enclosed application for an Experimental Permit for our proposed reusable vertical take-off, vertical landing suborbital vehicle operating out of the New Frontier Spaceport in MyState. The permitted vehicle will be flown for the purpose of research and development.

Certificate of Accuracy

I, Earnest J. Rocketman, as an officer or individual authorized to act for the corporation in permitting matters, certify this document as true, complete, and accurate.

Confidentiality Request

This application for an Experimental Permit contains trade secrets and proprietary commercial data that BlueSky Aerospace requests the FAA treat as confidential.

Please direct inquiries and correspondence to me at the above address, or call me at (777) 123-4567.

Respectfully yours,

Earnest J. Rocketman, Ph.D.
President and Chief Scientist

BlueSky Aerospace

Experimental Permit Application

for a

Vertical Launch & Landing

Reusable Suborbital Rocket

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1. Program Description

1.1 Program Description [§437.23]

BlueSky Aerospace is developing a suborbital launch program with the short-term and long-term goals of launching and landing a reusable suborbital rocket in an area south of SpaceCity, MyState. Our vehicle, the Vertical-Sky-1 or VS-1, will operate in an area owned by New Frontier Spaceport. The short-term goal is to launch the VS-1 for the purpose of research and development. This vehicle will carry only a pilot aboard. We are seeking an FAA Experimental Permit to conduct these research and development tests with our VS-1 vehicle.

The long-term goal of our program is to develop a reusable suborbital launch vehicle (Vertical-Sky-2 or VS-2) capable of carrying one pilot and two paying passengers to an altitude of 100 km so that the passengers can experience about four minutes of zero gravity. We plan to operate this vehicle under an FAA Launch License.

1.2 Vehicle Description [§437.23(a) & §437.23(b)(1-3)]

The Vertical-Sky-1 is a vertical launch single-stage vehicle that launches using a bi-propellant rocket engine burning RP-1 as the fuel and liquid oxygen as the oxidizer. The vehicle's dry weight is 3,978 lb. Gross liftoff weight is approximately 10,266 lb. Our rocket engine has a sea level thrust of 14,500 lb. The vehicle length is 23.2 ft and its diameter is 5.0 ft. Figure 1 and Figure 2 provide the vehicle's mass properties and dimensions, respectively. Figure 3 presents the thrust profile of the rocket engine during the rocket burn.

	Weight (lb)
Structure	1809
Thermal Protection	95
Landing System	286
Propulsion System	620
Power	259
Avionics	351
Environmental Control	234
Personnel Provisions	324
Dry Weight	**3978**
RCS Propellant	11
Landing Propellant	293
Residuals/Reserves	91
Ascent Propellant	5603
Propellant Weight	**5998**
Crew	250
Gross Weight	**10226**

Figure 1: Vehicle Mass Properties (Flight to 328,000 ft)

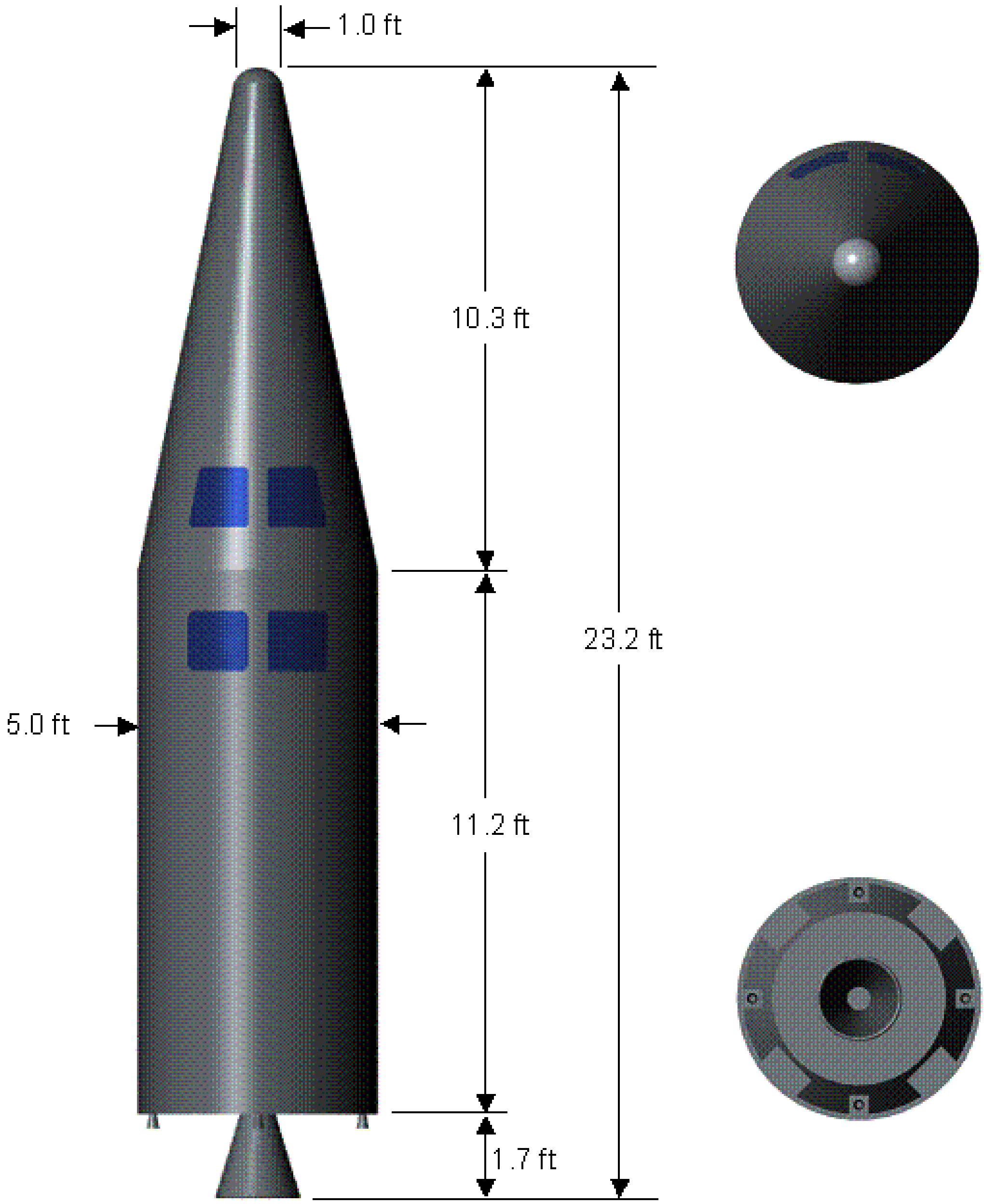

Figure 2: Vehicle Dimensions

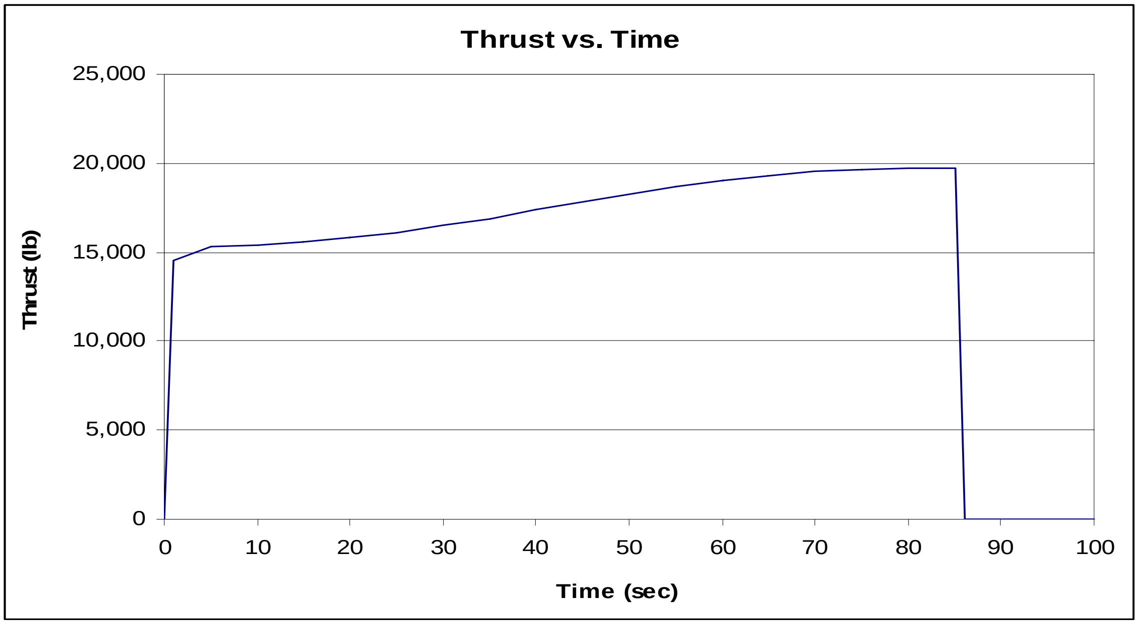

Figure 3: Rocket Engine Thrust Profile (Flight to 328,000 ft)

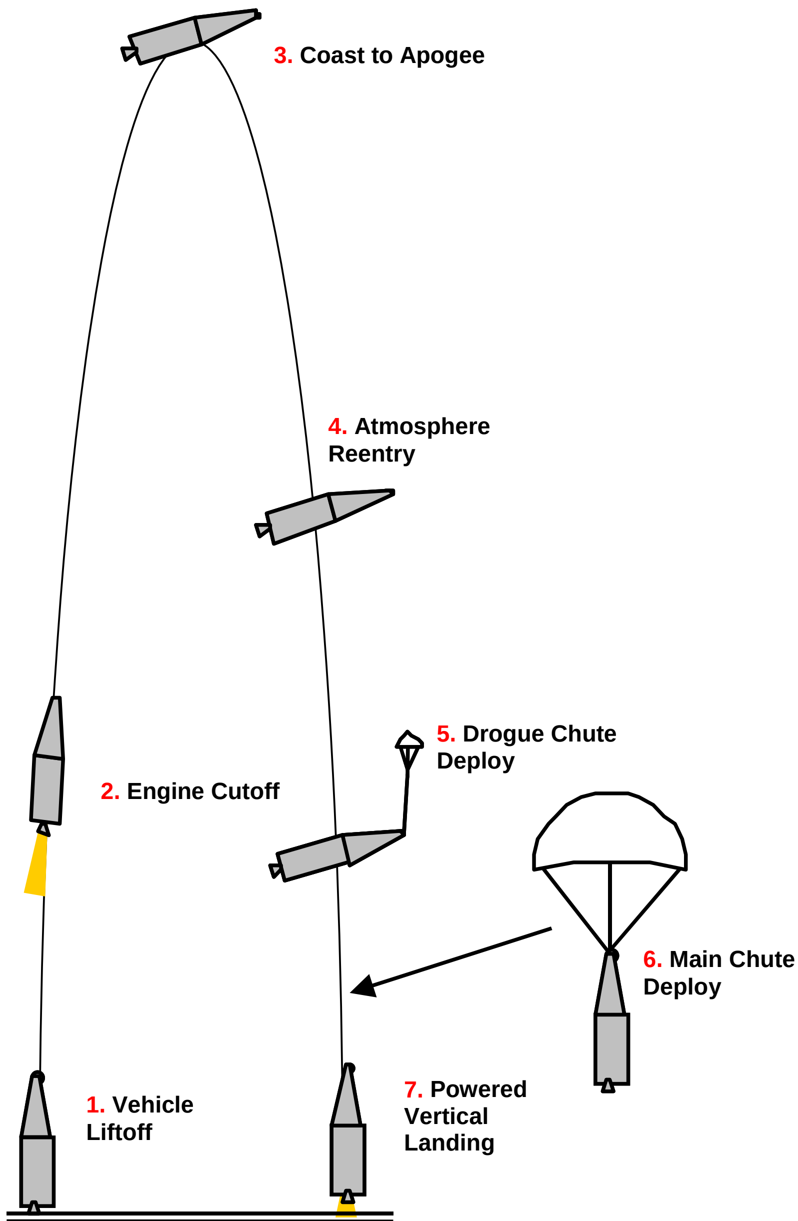

Figure 4: Mission Profile

Figure 4 depicts a typical mission profile for the vehicle. During experimental permitted flight-testing, the pilot will be the only human aboard the vehicle and will have full control of the vehicle from liftoff to landing. The mission begins with a vertical launch from a launch pad on the New Frontier Spaceport. After rocket engine cutoff, the vehicle coasts to an altitude of 328,000 ft (100 km), and then re-enters the atmosphere. A drogue chute deploys first, followed by the main parachute to reduce the vehicle's airspeed. At an altitude of approximately 200 ft, the pilot ignites the main rocket engine for a powered vertical landing at a downrange site.

1.2.1 Description of Reusable Suborbital Rocket Systems [§437.23(b)(1)]

1.2.1.1 Structural System Overview

As presented in Figure 5, the structure of the vehicle consists of three primary components—the aft structure, the crew cabin structure, and the nose cone structure—all of which are constructed with skin-stringer aluminum. The nosecone is topped with a high-temperature titanium plug.

The aft structure houses the main rocket engine, the oxidizer and fuel tanks, the landing gear, and the aft reaction control system (RCS) thrusters and tanks. The nose cone structure houses the avionics, the parachutes, and the nose RCS thrusters and tanks, and is maintained at cabin temperature and pressure.

The crew cabin has seating for one pilot forward and two passengers aft. The pilot seat has a center stick for pitch, roll, and yaw control. The flight control system will be described in more detail in the Flight Control System Overview section. The crew cabin is pressurized to 12 psi for normal operations. BlueSky used the following FAA/AST guidance document to determine the appropriate verification safety factors for all structures: *FAA/AST Guide to Verifying Safety-Critical Structures for Reusable Launch and Reentry Vehicles*. The environmental control system will be described in more detail in the Environmental Control System Overview section. The crew cabin has four dual-paned windows made of homogeneous plastic, to provide outside observation during the flight. A dehumidifier fan in the nose cone blows re-circulated cabin air between the two windowpanes of the four windows so that they do not fog over. The crew cabin has a hatch on the port side that provides entry and exit for the pilot.

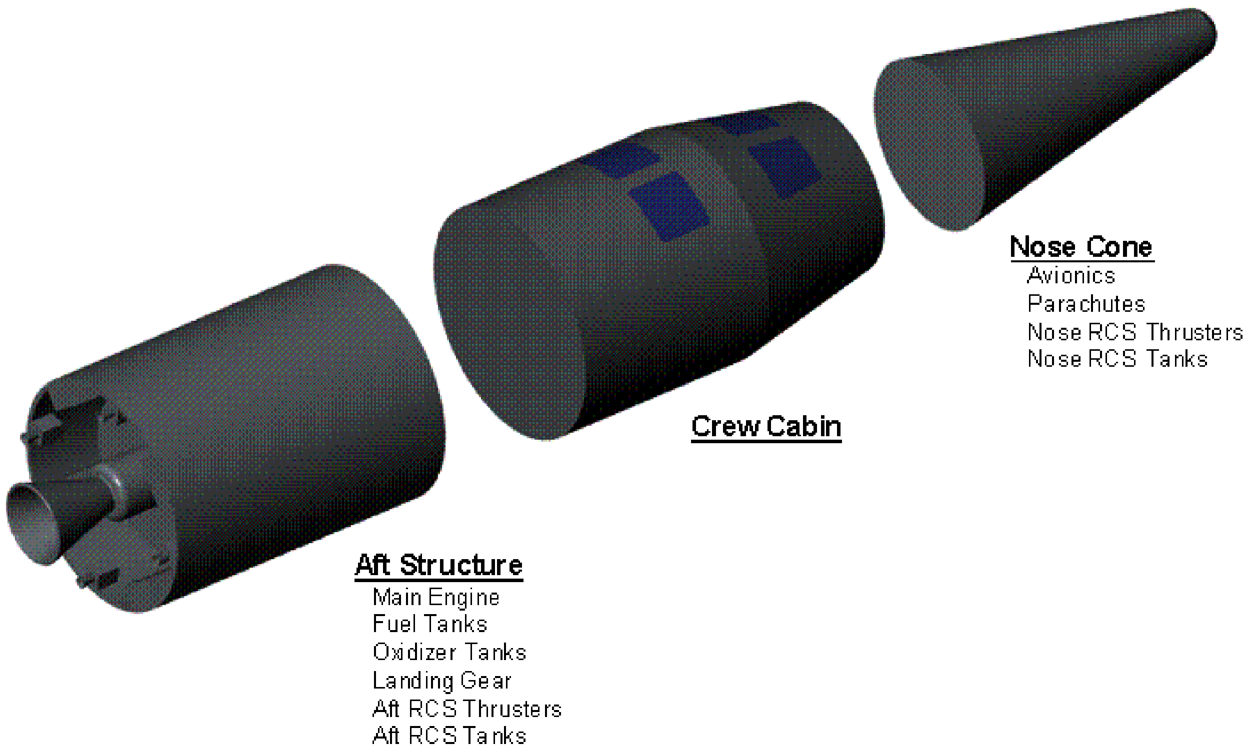

Figure 5: Primary Structural Components

1.2.1.2 Thermal System Overview

The vehicle has a thermal protection coating to protect the structure from heating during atmospheric reentry. This coating maintains the temperature of the underlying structure to less than 200 degrees Fahrenheit. The material used to provide the thermal protection for this vehicle is called sparesyl. This is a spray-on foam currently being used on expendable launch vehicle's (ELV's) payload fairings. Once applied to the vehicle, the sparesyl material protects the vehicle over many flights, and is easily inspected between flights. The thickness of the sparesyl tapers from 0.25 inch at the tip of the nose to 0.10 inch a foot aft of the tip of the nose. From that point the thickness is maintained at 0.10 inch. The sparesyl material is initially sprayed onto the outer surface of the vehicle. It is then molded to the desired thickness using trowels. Between flights, we will inspect the sparesyl coating. If any flight conditions do exceed the temperature limits of the sparesyl material, the resultant high outer skin temperature will produce first scorching; then charring, and possibly ablation. All these conditions will be evident upon inspection, and we can easily apply additional sparesyl before the next flight.

1.2.1.3 Propulsion System Overview

The propulsion system consists of the main rocket engine, which is used during the ascent and descent burns, and the reaction control system (RCS), which is used for attitude control.

The main propulsion system, our F-300 engine, consists of a single liquid propellant rocket engine using RP-1 for the fuel and liquid oxygen for the oxidizer. MyOwnRocket Inc, a contractor to BlueSky Aerospace, is building the F-300 engine. It has a sea level thrust of 14,500 lb and produces a moderate-level vacuum Isp of 300 sec. Figure 3 in the Vehicle Description section presents the thrust profile of the rocket engine during the rocket burn, where the increasing thrust is due to the reduction in atmospheric density during ascent. The rocket engine is a very simple, low-cost design. It does not have throttle or gimbal capabilities. It burns for approximately 85 seconds during liftoff, and relights for approximately 10 seconds during the vertical landing of the vehicle.

The fuel and oxidizer tanks are constructed with monocoque aluminum, and are housed in the aft structure. The fuel tank is filled through a fill port in the aft structure above the fuel tank, and has a dump port in the aft structure below the fuel tank. The oxidizer tank, which is the lower tank, is filled through a fill port in the aft structure above the oxidizer tank, and has a dump port in the aft structure below the oxidizer tank. In case of anomalies or an emergency during ascent, the pilot can open the oxidizer dump ports to dump the oxidizer from the vehicle. The fill ports and dump ports are connected to the tanks with braided steel flex hose.

The plumbing lines connect the fuel and oxidizer tanks to the main rocket engine and are braided steel flex hose.

The main function of the RCS propulsion system is to maintain attitude control during the main engine ascent/descent burns and the high-altitude coast phase of the flight. This system is completely controlled by the pilot of the vehicle using the center control stick. The RCS system uses gaseous nitrogen (GN2) as the propellant, and consists of a total of twenty thrusters and two small GN2 fuel tanks pressurized at 5000 psi in the nose and in the aft structure. The GN2 fuel tanks contain the required amount of GN2 for the flight plus an additional 25% as a safety margin.

Eight RCS thrusters are embedded in the nose structure. Two thrusters on the right side and two thrusters on the left side provide yaw control. Two thrusters on the top of the nose provide pitch control. The remaining two thrusters, on the right and left side, are canted downward to provide pitch and yaw control. One of the two GN2 tanks is mounted in the nose structure, and plumbing lines run from the tank to the eight nose thrusters.

Twelve RCS thrusters are embedded in the aft structure, with eight of the thrusters situated in a similar fashion to the thrusters on the nose to provide roll, pitch, and yaw control. The remaining four RCS thrusters are mounted to the inside base of the aft structure, at four points of the circle, to provide for additional pilot control during the powered landing of the vehicle. These base thrusters are fired to maintain the vehicle’s vertical orientation during the landing. One of the two GN2 tanks is mounted in the aft structure, and plumbing lines run from the tank to the twelve aft thrusters.

By pairing the thrusters for roll, pitch, and yaw control, the system is dually redundant. Figure 6 depicts the locations of the twenty RCS thrusters.

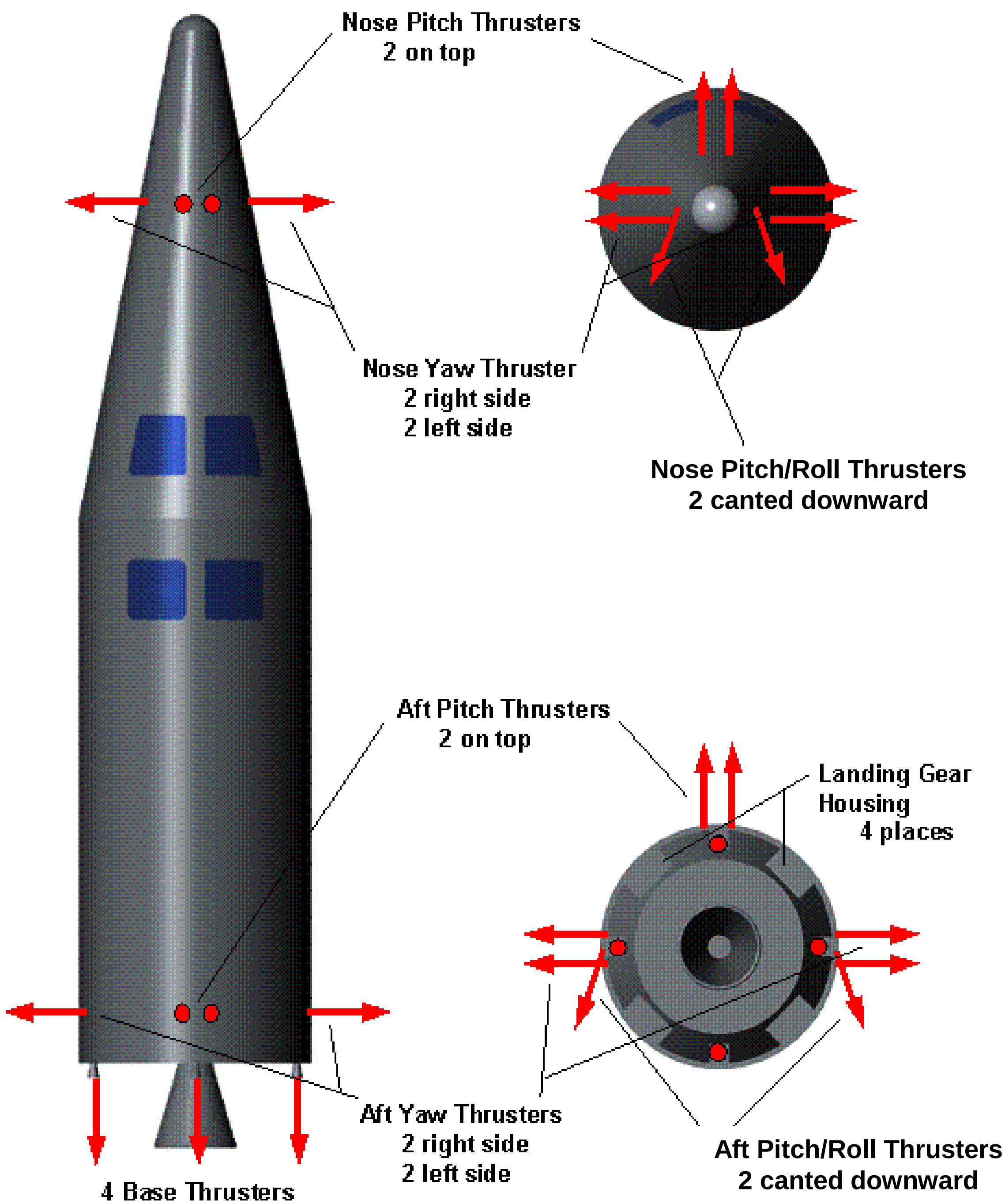

Figure 6: RCS Thruster Location

1.2.1.4 Landing System Overview

The landing system for the BlueSky vehicle consists of two main items—the parachute system and the landing gear.

The parachute system is housed in the nose cone structure, and is maintained at cabin temperature and pressure throughout the flight. The parachute system consists of a small drogue chute and a much larger main parachute. The pilot activates the deployment of both parachutes. The pilot deploys the drogue chute after atmospheric reentry to begin the initial deceleration of the vehicle as well as to rotate the vehicle to vertical. Once the vehicle reaches a vertical orientation, the pilot deploys the main parachute for the remainder of the descent.

The landing gear is housed in the aft structure of the vehicle. The landing gear consists of four landing struts that are extracted from four structural housings mounted inside the aft structure at four points of the circle. Figure 6 shows the location of the landing gear. The landing gear extends from the aft structure using high-tension springs. Once deployed, there is no on-board retraction capability for the landing gear. The pilot actuates the landing gear using a lever on the instrument panel on the left side of the center console after the parachute has fully deployed and the vehicle is in a stable descent. Though the normal operation of the vehicle calls for the main rocket engine to relight for a powered landing, the landing gear is designed to withstand the forces of an un-powered landing with just the parachutes.

The last phase of the landing occurs at an altitude of approximately 200 ft, when the main rocket engine relights for approximately 10 seconds to provide the final deceleration before touchdown.

1.2.1.5 Avionics and Guidance System Overview

The avionics and guidance system is composed of a central processor and a navigation box. The central processor, housed in the nose of the vehicle, controls the navigation and vehicle status functions. The navigation box houses the navigational sensors, including three-rate gyros, three accelerometers, two altitude-reporting systems, two Global Positioning System (GPS) receivers and antennas, and a telemetry transmitter and antenna. The two GPS antennas and the UHF telemetry antenna are mounted to the outer surface of the top of nose structure, flush with the surface. The information from the processor and the navigation unit is delivered to the pilot through two colored LCD monitors mounted on the center console in front of the pilot. The pilot can track important flight parameters such as altitude, position, velocity, vehicle orientation, projected instantaneous impact point (IIP), and propellant quantities. The fuel and oxidizer tank quantity gauges on the display are marked with a blue line that signifies the point at which the pilot should end the firing of the rocket engine during ascent. A warning system will provide the pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are exceeded. The central processor also contains a data storage unit that stores all of the vehicle parameters, such as position, velocity, attitude, accelerations, etc., for each flight. This data will be used to conduct the post-flight analysis, as well as to support any anomaly or mishap investigations.

The communication system consists of an audio panel on the right side of the center console controlling two communications transceiver radios. The antennas for both radios are mounted to the outer surface of the nose structure in separate positions to allow contact for all possible vehicle attitudes. Only the pilot is wired to the audio panel for radio transmit capabilities. A push-to-talk control for the pilot is located on the center control stick. Our communication system allows for real-time communication between our Ground Command Station and the pilot, as well as real-time communication between the Ground Command Station and ATC. Communications between ATC, Ground Command Station, and pilot that may affect the safety of the flight are recorded at our Ground Command Station.

1.2.1.6 Flight Control System Overview

The main flight controls for the pilot consist of the center control stick for pitch, roll, and yaw control. By moving the center control stick the pilot initiates electrical switches that control the firing of the correct combination of RCS thrusters. In addition to controlling the pitch, roll and yaw, the center control stick also has a push-to-talk control for the pilot to operate the radios as described in the Avionics and Guidance System Overview section and an engine on/off Fail-Safe Switch to control the fuel and oxidizer flow valves of the main engine. This Fail-Safe Switch is designed such that the rocket shuts down if the pilot releases the switch. The pilot holds down the engine on/off switch in order to fire the main rocket engine to begin the ascent, and releases the on/off switch once the vehicle has reached the target burnout conditions. The pilot also activates the engine on/off switch to fire the main rocket engine during landing. The pilot can release the engine on/off control at any time. At that point the rocket engine will stop firing. This capability allows for rocket engine shutoff during emergency conditions.

The instrument panel, located on the left side of the center console, contains the remaining flight controls. Most of these are on/off controls that are used during the various phases of flight. They are the:

- Engine Arm Switch,
- RCS Arm switch,
- Parachute Enable Switch,
- Drogue Chute Deploy Button,
- Main Chute Deploy Button,
- Landing Gear Deploy Lever,
- Battery Select Dial, and
- Oxidizer Dump Switch.

The Engine Arm Switch is activated before launch and enables the engine on/off control on the center control stick. The RCS Arm Switch is also activated before launch and enables the RCS control by the center control stick. The Parachute Enable Switch is activated during atmospheric reentry to enable the drogue and main chute controls. The Drogue Chute Deploy Button is pushed after atmospheric reentry to deploy the drogue chute to initiate deceleration of the vehicle as well as to rotate the vehicle to vertical. The Main Chute Deploy Button is pushed once the vehicle is in a vertical orientation, deploying the main chute for the remainder of the descent. The Landing Gear Deploy Lever is used to lower the landing gear after the parachute has fully deployed and the vehicle is in a stable descent. Once deployed the landing gear cannot be retracted during the flight.

Using the Battery Select Dial, the pilot can manually select between the two batteries.

The Oxidizer Dump Switch is used to enable the pilot to dump the oxidizer under emergency flight conditions.

1.2.1.7 Environmental Control System Overview

The environmental control system provides environmental conditions that enable the crew to perform their functions properly. It also helps to defog the windows, as well as provides cooling for the vehicle's avionics. Two tanks filled with pressurized air at 5000 psi are located in the nose cone of the vehicle. Each tank can provide the required air and pressurization for the entire flight. The pressurized air tanks maintain the crew cabin at near sea level pressure and at room temperature during the entire flight. The conditioned air is also vented through the nose cone of the vehicle to maintain the temperature and pressure of the avionics, flight controls, RCS components, and the parachutes in the nose cone.

The air is circulated throughout the crew cabin using an air conditioning unit that consists of fans, a CO_2 scrubber, and a dehumidifier. A fan is used to draw air into the CO_2 scrubber (which captures CO_2 and removes it from the air) and then into the dehumidifier (which traps moisture to dry the air). This clean dried air is then vented back into the cabin. As stated previously in the Structural System Overview section, a second dehumidifier fan in the nose cone blows re-circulated cabin air between the two windowpanes so that they do not fog over.

The environment of the crew cabin is controlled from the environmental control panel located on the bulkhead to the right of the pilot. One dial controls the main air-conditioning fan, and a second dial controls the window defog fan. Also located on the environmental control panel is a dial for each of the pressurized air tanks. Each of these dials has three settings: off, on, and emergency. For a typical flight, only one of the tanks needs to be turned on. If there is a drop in cabin pressure (caused, for example, by a puncture of the structure), both tanks can be turned to the emergency setting. Air is then vented into the crew cabin to maintain cabin pressure.

The environmental control panel also contains environmental indicator gauges, including gauges for crew cabin pressure, temperature, and relative humidity, as well as gauges for CO_2 and O_2 concentration levels. A warning system will provide the pilot with audible and visual signals when safe operating ranges of these safety-critical flight parameters are exceeded.

1.2.1.8 Pneumatic/Hydraulic System Overview

N/A. The vehicle uses only electro-mechanical actuation, and does not contain any pneumatic or hydraulic systems.

1.2.1.9 Electrical System Overview

Two lithium-ion batteries housed in the nose structure provide the power for the avionics and guidance system, the flight control system, and the environmental control system. Each battery is capable of providing power for all systems for the duration of the flight, providing for dual redundancy. Using the Battery Select Dial, the pilot can manually select between the two batteries.

1.2.1.10 Software and Computing Systems Overview

A list of the functional systems that contain software is provided below. The software safety approaches used follow the FAA/AST *Guide to Reusable Launch and Reentry Vehicles Software and Computing System Safety*.

- Global Positioning System (GPS)
- Inertial Measurement Unit (IMU)
- Flight Display
- Propulsion System Health Monitoring
- Air Data Sensing
- Flight Control Systems
- Environmental Control System Health Monitoring

1.3 Vehicle Purpose [§437.23(b)(4)]

During the experimental phase of the program, the VS-1 will be flown for research and development to test a reusable vertical launch and landing design concept.

1.4 Payload Description [§437.23(b)(5)]

BlueSky plans to fly the Atmospheric CO_2 Sensor Instrument. The Atmospheric CO_2 Sensor Instrument is a scientific payload designed to measure the CO_2 levels at various altitudes during flight.

1.5 Foreign Ownership [§437.23(c)]

BlueSky Aerospace is a 70% American-owned corporation, with 30% foreign interests or participating entities. World Space Launch International, United Kingdom, controls a 30% stake in BlueSky Aerospace.

2. Flight Test Plan

2.1 Flight Test Plan Description [§437.25(a)]

This is an incremental testing program. Our flight test program is scheduled to begin in the fall of 2006. The locations of our tests are the Military Rocket Range and the New Frontier Spaceport. Initial tests will focus on the ground and flight tests of some key systems of our launch vehicle, such as the reaction control system, the parachute deployment system, and the landing system. These tests will provide the verification data to support the mitigation measures of our hazard analysis. Given that these tests do not include the launch of a launch vehicle, they will not require an FAA Experimental Permit. Later tests of our suborbital rocket, the VS-1, will require an Experimental Permit. Table 1 contains a summary of our testing program.

Table 1 Planned Flight Test Summary

Flight Test	Location	Maximum Altitude	Number of Tests	With Pilot	Exp. Permit Required
1. Helicopter drop test, dummy weight	Military Rocket Range	10,000 ft	4	No	No
2. Helicopter drop test, no main engine	Military Rocket Range	10,000 ft	8	No	No
3. Helicopter drop test, with main engine	Military Rocket Range	10,000 ft	6	Yes	No
4. Vertical launch to 40,000 ft	New Frontier Spaceport	40,000 ft	5	Yes	Yes
5. Vertical launch to 328,000 ft	New Frontier Spaceport	328,000 ft	3	Yes	Yes

Flight Test #1: The first set of tests will focus on the parachute deployment system. A dummy weight will represent the vehicle during these tests. We will drop the dummy weight and the attached parachute deployment system from a helicopter at an altitude of 10,000 ft. Once clear of the helicopter, the drogue parachute will deploy, followed by the main parachute. Our ground-based remote control will initiate the parachute deployment sequence.

Flight Test #2: The second set of tests will demonstrate the un-powered landing sequence of our vehicle with a dummy weight in place of the main rocket engine. The helicopter will carry the vehicle aloft to an altitude of 10,000 ft. The helicopter will drop the vehicle with its landing gear fully deployed and locked in place. The pilot will control the RCS thrusters and the parachute deployment from the ground. The vehicle will land un-powered using its main parachute.

Flight Test #3: The third set of tests will demonstrate the powered landing sequence. Our testing helicopter will carry the vehicle to 10,000 ft. The helicopter will then drop the vehicle, with its landing gear fully deployed and locked in place to simulate a typical descent. The pilot will control the RCS thrusters and the parachute deploy from within the vehicle. When the vehicle has descended to an altitude of approximately 200 ft above the ground, the pilot will ignite the main rocket engine to provide the final deceleration until touchdown. As our program progresses the helicopter will drop the vehicle with the landing gear retracted. The pilot will then deploy the landing gear prior to landing.

Flight Test #4: The fourth series of tests requires an FAA Experimental Permit. These tests will originate at the New Frontier Spaceport. The vehicle will be mounted onto its launch stand with enough propellant to carry it to an altitude of 40,000 ft, as well as enough propellant for a powered landing. An altitude of 40,000 ft will provide sufficient margin for the pilot to deploy the parachutes. The pilot will then deploy the landing gear while using the RCS thrusters to vertically stabilize the vehicle. At approximately 200 ft, the pilot will ignite the main rocket engine to decelerate the vehicle until touchdown.

Flight Test #5: The fifth series of tests requires an FAA Experimental Permit. These tests will originate at the New Frontier Spaceport. The vehicle will be mounted on its launch stand with the propellant tanks fully loaded. The pilot will initiate the firing of the main rocket engine carrying the vehicle to an altitude of 328,000 ft. As the vehicle passes back through 30,000 ft, the pilot will initiate the deployment of the drogue parachute, followed by the main parachute. The pilot will then deploy the landing gear and ignite the main rocket engine at approximately 200 ft above the ground for final deceleration and touchdown.

List of Key Flight-Safety Events: For the flights originating at the New Frontier Spaceport, the key flight-safety events are the:

- Main rocket engine ignition,
- Parachute deployment,
- RCS attitude control ignition sequence,
- Powered landing, and
- Envelope expansion flight(s) from 40,000 ft to 328,000 ft.

2.2 Description of Proposed Operating Area(s) [§437.25(b-c)]

The New Frontier Spaceport is located near SpaceCity, MyState. This location lies along the western boundary of the Military Rocket Range, and will benefit from the controlled airspace around the Military Range. The Spaceport encompasses a 27 square mile site consisting of open land with an average elevation of 4,700 ft. The Spaceport facilities include a launch complex, a 12,000 ft runway and aviation complex, a payload assembly complex, a support facilities complex, and a system development complex.

The location of the Spaceport, and its proximity to the Military Rocket Range, are presented in Figure 7. The proposed operating areas for our test program are shown in Figure 8.

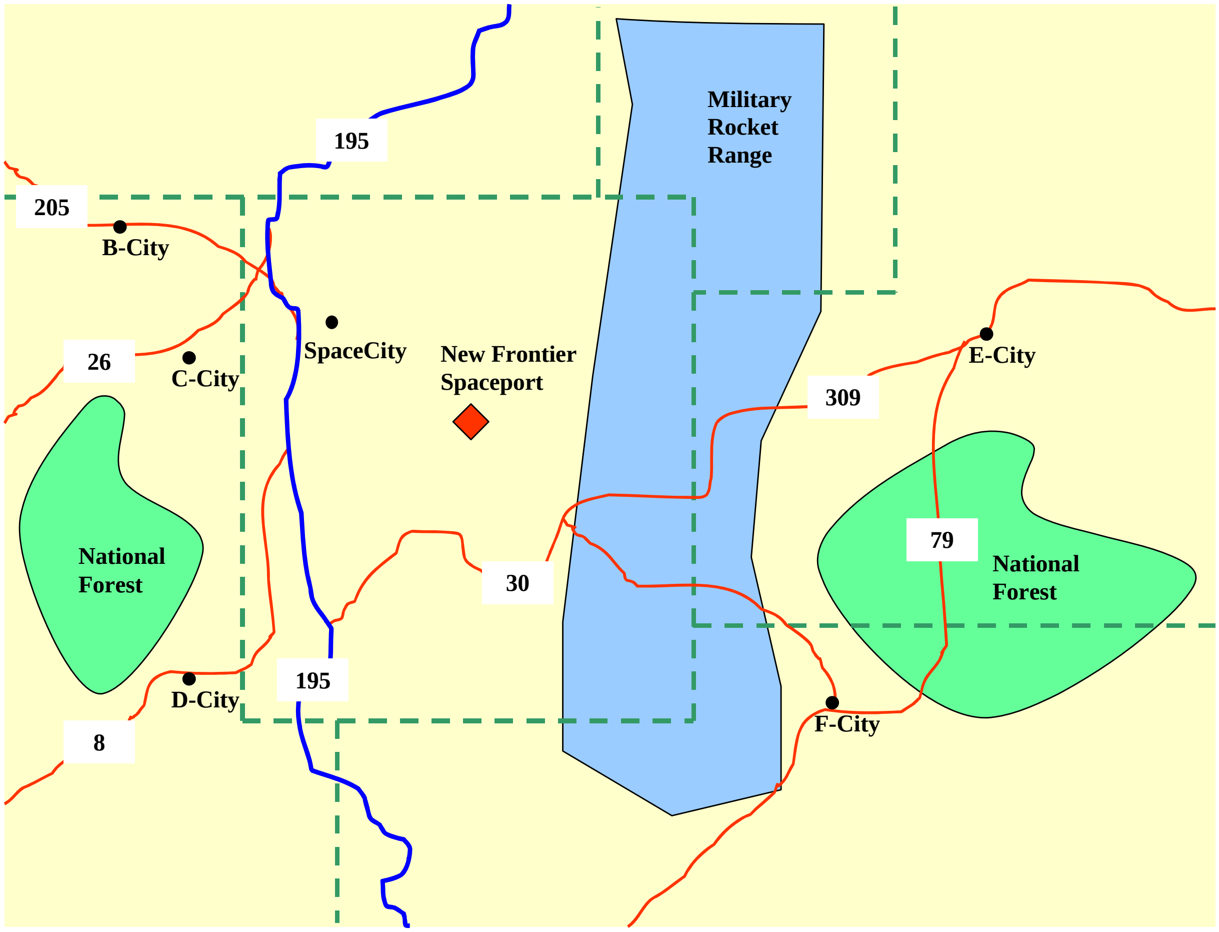

Figure 7: Location of New Frontier Spaceport

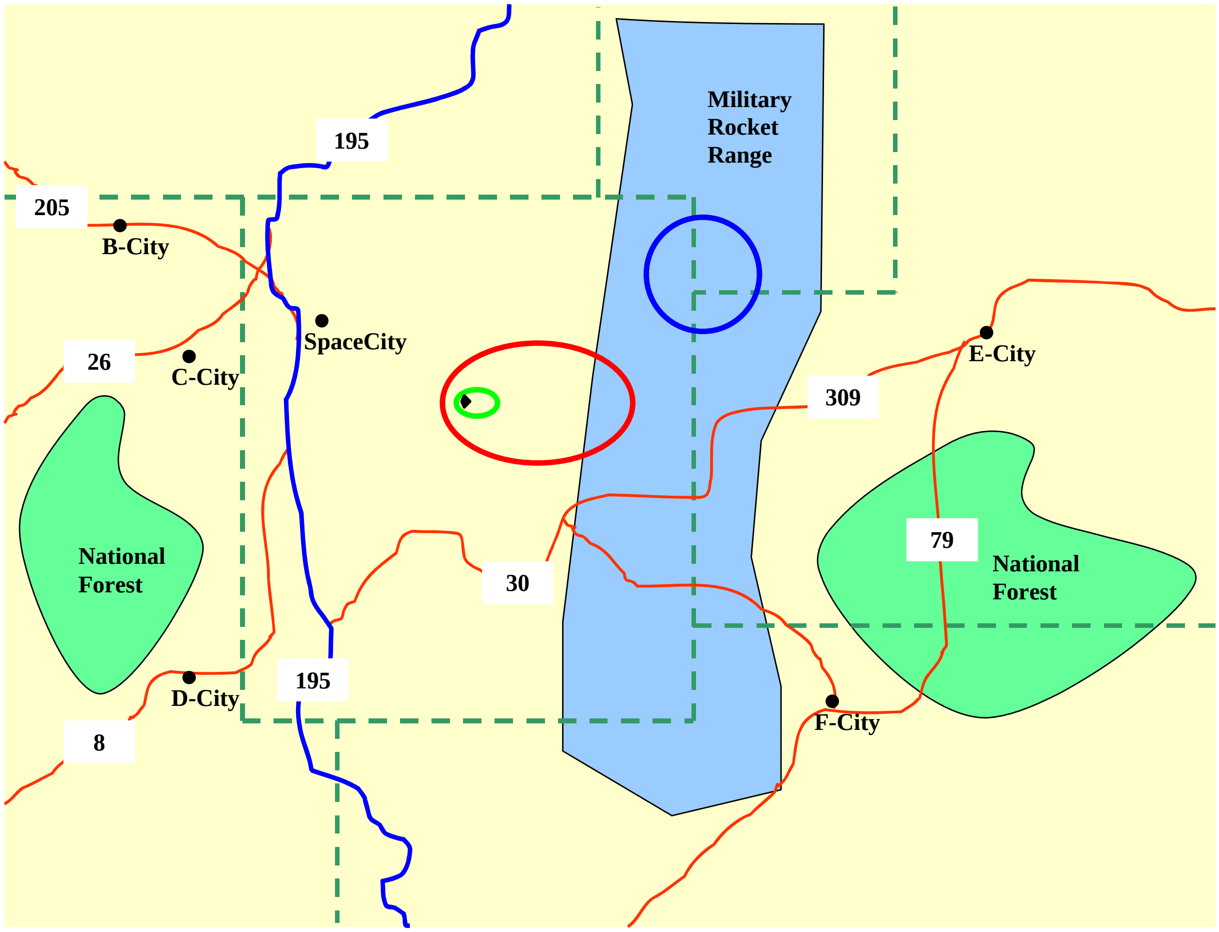

Figure 8: Operating Areas for Test Flights

Initial Test Operating Area: The blue circle in Figure 8 shows the 6 nm radius operating area on the Military Rocket Range that will be used for the helicopter drop tests. These are flight test series 1 through 3.

Primary Flight Test Operating Area (Flights to 40,000 ft): The green oval in Figure 8 shows the proposed operating area for our permitted flight tests. It is a volume defined by an ellipse that is 4 nm long by 3 nm wide and extends upward to 50,000 ft. The black diamond is the location of our launch site. The boundary of the operating area is an ellipse defined by the equation: $(x/a)^2 + (y/b)^2 = 1$, where b = 1.5 nm (width) and a = 2 nm (length). The boundary of this operating area is defined by the following:

- Longitude: 106° 53’ 00” W and 106° 58’ 00” W
- Latitude: 32° 54’ 00” N and 32° 57’ 00” N
- Maximum height of 50,000 ft

- Axes of the ellipse: 106° 55’ 30” W longitude and 32° 55’ 30” N latitude

Primary Flight Test Operating Area (Flights to 328,000 ft): The red solid-lined oval in Figure 8 shows the operating area for our permitted flight tests. It is a volume defined by an ellipse that is 20 nm long by 13 nm wide and extends upward to 350,000 ft. The black diamond is the location of our launch site. The boundary of the operating area is an ellipse defined by the equation: $(x/a)^2 + (y/b)^2 = 1$, where b = 6.5 nm (width) and a = 10 nm (length). The boundary of this operating area is defined by the following:

- Longitude: 106° 38’ 00” W and 107° 02’ 00” W
- Latitude: 32° 48’ 30” N and 33° 01’00” N
- Maximum height of 350,000 ft
- Axes of the ellipse: 106° 50’ 00” W longitude and 32° 55’ 30” N latitude

3. Operational Safety Documentation

3.1 Pre-Flight and Post-Flight Operations [§437.27 & §437.53(a-b)]

On the day of flight, the VS-1 vehicle will be transported to the launch site from a vehicle processing facility using a flatbed truck. Only launch processing crews and the flight crew will be allowed at the launch site while performing operations under the experimental permit. The justification and method used to determine our safety clear zone is described below.

A 1,250-feet radius circle defines our “safety clear zone.” This is our acceptable minimum safe distance during pre-flight and post-flight operations. Greater distances will be used whenever practicable to maximize public safety and minimize potential damage to nearby facilities and equipment. In addition, at T-30 minutes and T-5 minutes prior to each flight test, BlueSky will conduct helicopter surveillance of the operating area to clear the operating area of all uninvolved personnel. If anyone is detected in the operating area, the countdown to launch will be stopped (i.e., “No-Go” status). Our safety official will be dispatched to confirm that the operating area is cleared of all personnel.

The flight vehicle is initially loaded with RP-1 and GN2. When oxidizer is added, the status of the area around the vehicle changes to Hazard Class 1, Division 1.1 (HC/D 1.1). It is important to minimize the timeline of a vehicle when it is in this state and to minimize the number of people who are exposed to it. Explosive siting for Hazard Class 1 is based on the quantity of explosive material and separation distance relationships (QD) that provide defined types of protection. Explosive siting criteria for the BlueSky vehicle were selected to satisfy, as a minimum, the requirements found in Appendix D of 14 CFR Part 420.63 and DOD 6055.9, “DOD Ammunition And Explosives Safety Standards.” Additional guidance is taken from Department of Transportation, Federal Aviation Administration, Commercial Space Transportation; “Waiver of Liquid Propellant Storage and Handling Requirements for Operation of a Launch Site at the Mojave Airport in CA” (Federal Register / Vol. 69, No. 130 / Thursday, July 8, 2004 / Notices).

The vehicle is subject to appropriate QD criteria based on type and weight of the fuel and oxidizer on board. For the purpose of explosive siting, the total weight of the flight vehicle fuel and oxidizer plus the weight of the oxidizer in the servicing tanker are considered in establishing the appropriate QD area for the loading area. In accordance with DOD 6055.9-STD, Rev 5, Tables C9-T18 and C9-T1, the vehicle loading area will be located a minimum of 1,250 feet from any inhabited building.

Post-flight operations begin upon landing. Any oxidizer remaining in the vehicle is removed through the oxidizer dump port, at which point the vehicle's status is downgraded to "non-explosive." Any remaining fuel is then removed through the fuel dump port. The vehicle is then rotated onto our flatbed truck to a horizontal orientation and transported to a vehicle processing facility to prepare for the next flight.

3.2 Hazard Analysis [§437.29 & §437.55(a)]

BlueSky's hazard analysis process consists of four parts:

1) Identifying and describing the hazards,

2) Determining and assessing the risk for each hazard,

3) Identifying and describing risk elimination and mitigation measures, and

4) Validating and verifying risk elimination and mitigation measures.

Our assessment of the risks is a qualitative process. Risk accounts for both the likelihood of occurrence of a hazard and the severity of that hazard. The levels for the likelihood of occurrence of a hazard, presented in Table 3, and the categories for the severity of a hazard, presented in Table 2, were used in combination with the four-step hazard analysis process to develop our list of hazards. The severity and likelihood are combined and compared to criteria in a risk acceptability matrix, as shown in Table 4. BlueSky used the following FAA/AST guidance document to perform its hazard analysis: *AC 437.55-1, Hazard Analysis for the Launch or Reentry of a Reusable Suborbital Rocket Under an Experimental Permit.*

As our flight test program progresses, there will be anomalies that will be credited to component, subsystem, or system failures or faults; software errors; environmental conditions; human errors; design inadequacies; and/or procedural deficiencies. As these anomalies occur during our program, a risk elimination/mitigation plan will be developed. In addition, BlueSky will provide verification evidence (i.e., test data, demonstration data, inspection results, and analyses) in support of our risk elimination/mitigation measures. Our hazard analysis will be continually updated as our test program progresses. See Appendix D for a list of the identified hazards. Appendix E provides a description of our verification schedule.

Table 2 Severity of Hazard

Description	**Category**	**Consequence Definition**
Catastrophic	I	Death or serious injury to the public or safety-critical system loss.
Critical	II	Major property damage to the public, major safety-critical system damage or reduced capability, decreased safety margins, or increased workloads.
Marginal	III	Minor injury to the public or minor safety-critical damage.
Negligible	IV	Not serious enough to cause injury to the public or safety-critical system damage.

Table 3 Likelihood of Occurrence of Hazard

Description	**Level**	**Individual Item**
Frequent	A	Likely to occur often in the life of an item, with a probability of occurrence greater than 10^{-2} in any one mission.
Probable	B	Will occur several times in the life of an item, with a probability of occurrence less than 10^{-2} but greater than 10^{-3} in any one mission.
Occasional	C	Likely to occur sometime in the life of an item, with a probability of occurrence less than 10^{-3} but greater than 10^{-5} in any one mission.
Remote	D	Unlikely but possible to occur in the life of an item, with a probability of occurrence less than 10^{-5} but greater than 10^{-6} in any one mission.
Extremely Remote	E	So unlikely, it can be assumed occurrence may not be experienced, with a probability of occurrence less than 10^{-6} in any one mission.

Table 4 Risk Acceptability Matrix

Severity / Likelihood	Catastrophic I	Critical II	Marginal III	Negligible IV
Frequent (A)	1	3	7	13
Probable (B)	2	5	9	16
Occasional (C)	4	6	11	18
Remote (D)	8	10	14	19
Extremely Remote (E)	12	15	17	20

Category 1 – High (1-6, 8). Elimination or mitigation actions must be taken to reduce the risk.
Category 2 – Low (7, 9-20). Risk is acceptable

3.3 Operating Area Containment

3.3.1 Methods of Containment [§437.31 & §437.57(a)]

There are three methods of containing our vehicle's instantaneous impact point within the operating area. The first is the use of a Monte Carlo analysis to define a large enough operating area to contain all dispersions resulting from the vehicle pitching or yawing less than or equal to ±5 deg/sec. As described in Appendix A, a Monte Carlo trajectory analysis was performed to determine possible impact locations. An operating area was then specified that would encompass all of these impact locations.

The second method for containing the vehicle's instantaneous impact point within the operating area focuses on mitigating the malfunctions, as identified in the Hazard Analysis section, which could cause the vehicle to pitch or yaw at greater than ±5 deg/sec.

The third method for containing the vehicle's instantaneous impact point within the operating area is the pilot's ability to detect an anomaly and shutdown the rocket engine firing within 5 seconds. This is accomplished by releasing the engine on/off Fail-Safe Switch on the center control stick, as described in the Flight Control System Overview section, and as dictated by our flight rules (see Flight Rules). Since the LCD monitor displays flight parameters such as altitude, position, velocity, orientation, and projected IIP as described in the Avionics and Guidance System Overview section, the pilot will immediately be aware of any variations in the flight path and can end the rocket engine firing at any time.

3.3.2 Population [§437.31(a) & §437.57(b)]

In addition to the airspace and the geographic location, the population of the region was also a factor in developing our test program. The population density (Figure 9) model covering the Spaceport region is based on the Global Population Database. The operating areas for our test program are located in areas with population densities less than 10 people per square km, the closest high population centers being SpaceCity, 30 miles to the west, and C-City, 45 miles to the south. Areas designated by the population database as being unpopulated will serve as the locations of the key flight-safety events. The landing and impact locations will be visually surveyed before launch.

The source of the population data is the Global Population Database from Oak Ridge National Laboratory in Oak Ridge, Tennessee. The Global Population Database is a worldwide population database with a 0.5-minute by 0.5-minute resolution. Population counts are apportioned to grid cells based on likelihood coefficients, which in turn are based on proximity to roads, land cover, nighttime lights, and other information.

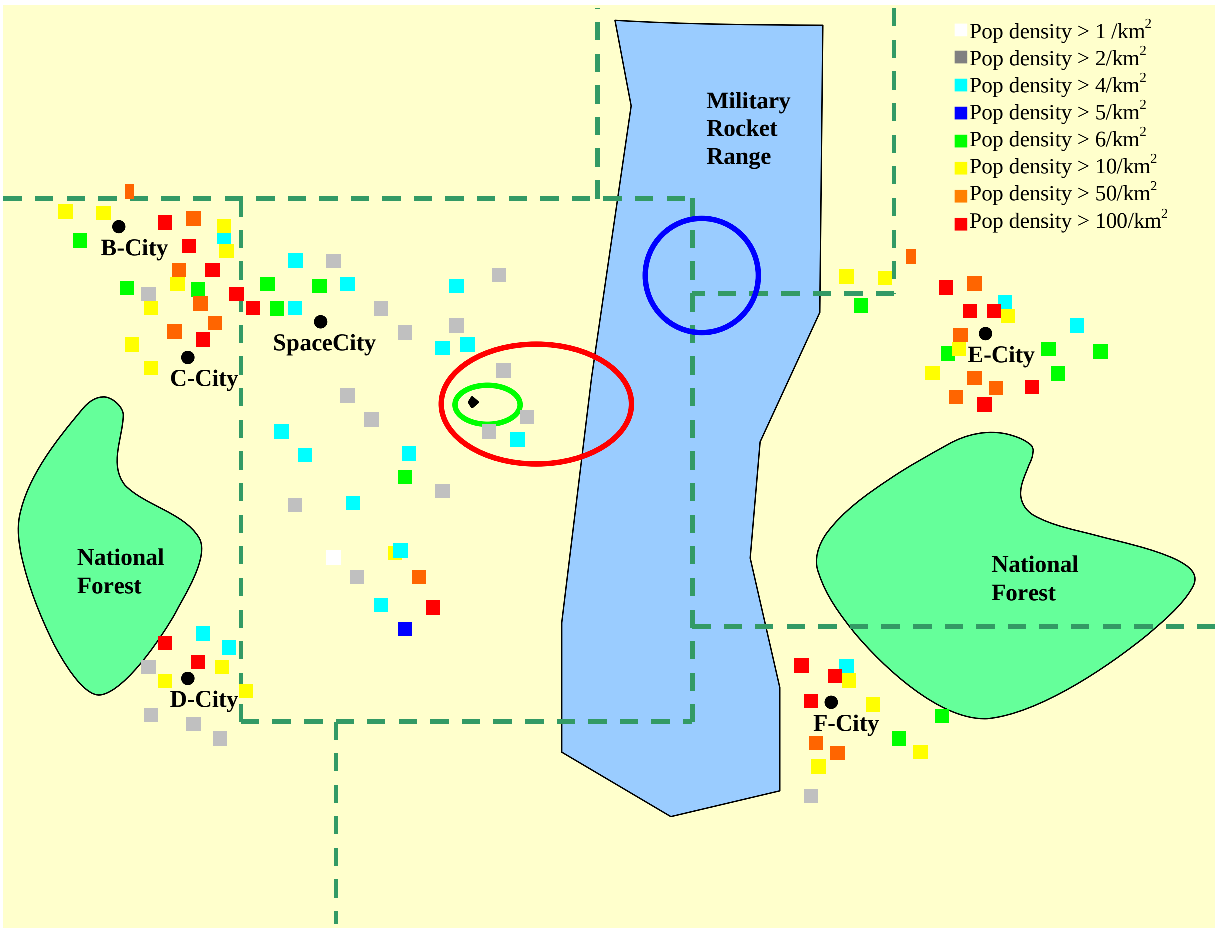

Figure 9: Population Density for New Frontier Spaceport and Operating Areas

3.3.3 Significant Traffic [§437.31(a) & §437.57(b)]

The primary operating area does not contain significant automobile traffic, railway traffic, waterborne vessel traffic, or large concentrations of the public.

3.4 Key Flight-Safety Event Limitations

3.4.1 Key Flight-Safety Events [§437.31(b) & §437.59(a)]

As described in the Flight Test Plan Description section of this document, and as summarized in Table 1, our flight test plan involves an incremental testing program. For the vertical launch tests originating at the New Frontier Spaceport, the key flight-safety events are the:

- Main rocket engine ignition,
- Parachute deployment,
- RCS attitude control ignition sequence,
- Powered landing, and
- Envelope expansion flight(s) from 40,000 ft to 328,000 ft.

These events will be conducted over unpopulated areas. Table 5 provides the geographical coordinates of the instantaneous impact points for these events. Figures 10 and 11 show the locations of the impact points' expected dispersions, which are over unpopulated areas within our operating area. These areas will be surveyed visually prior to launch to verify that they are unpopulated.

BlueSky's method for conducting key flight-safety events over unpopulated or sparsely populated areas is to have the pilot verify that the vehicle's IIP is over unpopulated or sparsely populated areas prior to initiating any of these events. The LCD within our vehicle monitors flight parameters such as altitude, position, velocity, orientation, and projected IIP (as described in the Avionics and Guidance System Overview section). The pilot will be aware of any variations in the flight path and will only initiate a key flight-safety event if the vehicle's IIP is over an unpopulated or sparsely populated area (see Flight Rules).

The verification evidence for the methods and systems used to conduct key flight-safety events over unpopulated or sparely populated areas is detailed in the Hazard Analysis section.

Table 5 Location of Key Flight-Safety Events IIPs (Primary Flight Test Operating Areas)

Event	**Flight to 40,000 ft**		**Flight to 328,000 ft**	
	Latitude	**Longitude**	**Latitude**	**Longitude**
Ignition	32° 55' 30" N	106° 57' 00" W	32° 55' 30" N	106° 57' 00" W
Parachute Deploy	32° 55' 30" N	106° 55' 00" W	32° 55' 30" N	106° 43' 00" W
RCS Attitude Control Ignition & Powered Landing	32° 55' 30" N	106° 54' 10" W	32° 55' 30" N	106° 42' 18" W

3.4.2 Reentry Impact Point [§437.31(b) & §437.59(b)]

Both reentry impact points for our 40,000 ft and 328,000 ft flights are located in unpopulated areas. As such they do not loiter over populated areas. Figures 10 and 11 show the locations of the reentry impact points' expected dispersions. The geographical coordinates for the reentry impact points are the following:

- 40,000 ft - Latitude: 32° 55' 30" N - Longitude: 106° 55' 30" W
- 328,000 ft - Latitude: 32° 55' 30" N - Longitude: 106° 43' 30" W

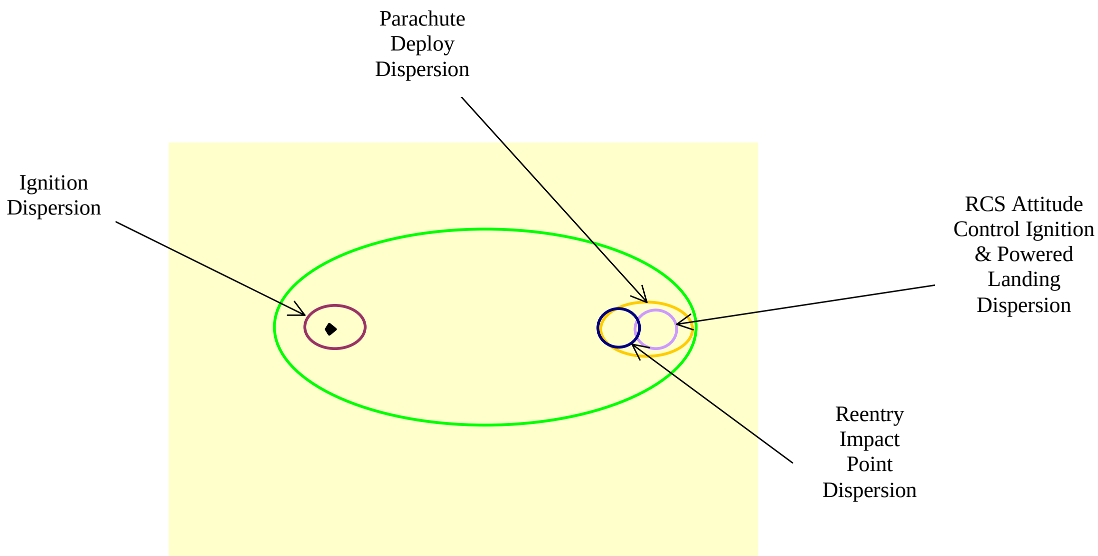

Figure 10: Three-Sigma Dispersion Ellipses for Flights to 40,000 ft

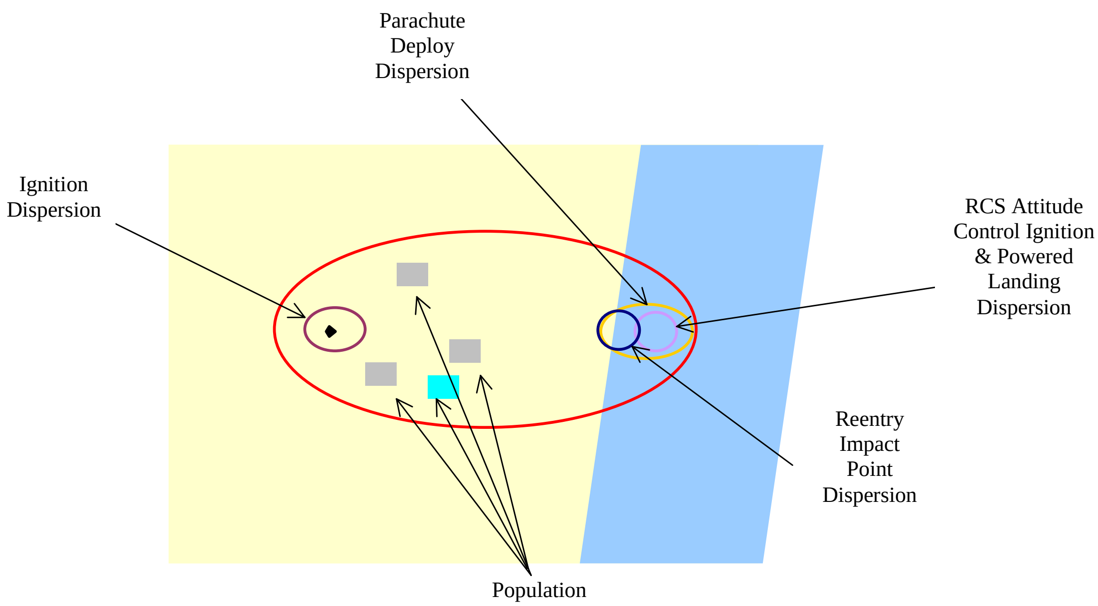

Figure 11: Three-Sigma Dispersion Ellipses for Flights to 328,000 ft

3.5 Landing and Impact Locations [§437.33 & §437.61]

The landing and impact areas for the vehicle are within the boundary of our operating areas (see Figures 10 &11). The landing areas encompassed by the operating areas are of sufficient size to contain an uncontrolled impact, including debris dispersion upon impact (see Appendix A: Details and Assumptions of the Monte Carlo Analysis). Based on the requirements found in Appendix D of 14 CFR Part 420.63 and DOD 6055.9, “DOD Ammunition And Explosives Safety Standards,” the maximum blast radius for an impact of the vehicle (assuming fully loaded) is 1,250 ft radius. This defines the safety clear zone around our vehicle at landing (See Flight Rules).

3.6 Agreements [§437.35 & §437.63]

BlueSky Aerospace has an agreement with New Frontier Spaceport to have full access and use of their property and services required to support our permitted flight(s). We also have an agreement with Military Rocket Range to operate within its boundaries during the landing phase of our flights.

New Frontier Spaceport has an agreement with FAA Air Traffic Control as part of it launch site operator license. This agreement governs the use of the airspace within the operating area. The agreement documents procedures to be used by New Frontier Spaceport, BlueSky Aerospace, and the FAA in implementing NOTAMS, air route closings, flight operations, and notifications.

Copies of all agreements are included with this application.

An agreement with the U.S. Coast Guard is not necessary, since the flights will not involve overflight of water.

3.7 Collision Avoidance Analysis [§437.65]

N/A. A collision avoidance analysis is not required from United States Strategic Command or Federal launch range since our maximum altitude of 100 km is lower than the FAA threshold of 150 km.

3.8 Tracking a Reusable Suborbital Rocket [§437.37 & §437.67]

BlueSky Aerospace will operate the vehicle in coordination with the FAA/ATC. As stated in the Avionics and Guidance System Overview section, the pilot can track important flight parameters such as altitude, position, velocity, vehicle orientation, and projected instantaneous impact point (IIP). In addition, the vehicle’s communications system consists of two communications transceiver radios for two-way communication between the pilot and our Ground Command Station. The Ground Command Station will maintain two-way communication with Air Traffic Control from launch to landing.

Also, as stated in Avionics and Guidance Overview section, the vehicle’s central processor contains a data storage unit that stores all of the vehicle parameters such as position, velocity, attitude, accelerations, etc., for each flight. These data will be used to conduct the post-flight analysis, as well as support any anomaly or emergency investigations.

3.9 Flight Rules

3.9.1 Pre-Flight Checklist [§437.39 & §437.71(a)]

Before initiating rocket-powered flight, BlueSky Aerospace will confirm that all systems and parameters are within acceptable limits (Appendix B: *BlueSky Checklist and Flight Rules*).

3.9.2 All Phases of Flight [§437.39 & §437.71(b)]

During all phases of flight, BlueSky Aerospace will adhere to its flight rules. If at any time the vehicle is in a state that could endanger the uninvolved public, the flight will be aborted. If this occurs during the main rocket engine burn, the pilot will immediately end the rocket engine burn and prepare the vehicle for an emergency parachute landing (Appendix B: *BlueSky Checklist and Flight Rules*).

3.10 Mishap Response [§437.41 & §437.75(b)]

BlueSky Aerospace will designate a point-of-contact and alternate for all activities associated with accidents, incidents, or other mishaps related to operations on or off the Spaceport. The designated point-of-contact and/or alternate will:

- Represent the vehicle operator as a member of the Emergency Response Team (ERT) and support the Spaceport Emergency Response Coordinator (ERC) by participating in the activities of the ERT during accidents, incidents, or mishaps.
- Ensure that the consequences of a mishap are contained and minimized.
- Assure that all data and physical evidence related to any accident, incident, or mishap is impounded to preclude loss of information essential to subsequent investigations.
- Identify and adopt preventive measures for avoiding recurrence of the event.
- Through the Spaceport ERC, report to and cooperate with FAA and National Transportation Safety Board (NTSB) investigations and act as the vehicle operator point-of-contact for the FAA and NTSB.

The company's detailed procedures for responding to a mishap are found in the following document: *Mishap Response Plan*. See Appendix C.

4. Environmental Impacts Analysis Information [§437.21(b)(1)]

BlueSky will provide the FAA with the information needed to analyze the environmental impacts associated with our proposed reusable suborbital rocket launches. This will enable the FAA to comply with the requirements of the National Environment Policy Act, 42 U.S.C. 4321 et seq. (NEPA), and the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA, 40 CFR parts 1500–1508. Environmental data is included with this application. See Appendix C.

5. Compliance with Additional Requirements

5.1 Information Requirements for Operations with Flight Crew and Space Flight Participants [§437.21(b)(3), Part 460]

BlueSky Aerospace provided the following documents demonstrating compliance with the requirements outlined in Part 460—Human Space flight Requirements. Specifically, we will comply with Subpart A—Launch and Reentry With Crew since our permitted test flights are R&D in nature and include only a pilot as flight crew.

5.1.1 Crew Qualifications and Training [§437.21(b)(3), §460.5 & §460.7]

- Documentation verifying the pilot's FAA 2nd-class medical certificate issued within the past 12 months prior to launch. See Appendix C.

- Documentation verifying the FAA pilot certificate with an instrument rating demonstrating the pilot's knowledge of the NAS. See Appendix C.

- Training program documentation (Appendix C) includes:
    - A description of the training program including how the pilot will be trained in every phase of the flight.
    - A description of the simulator training for each pilot to familiarize the pilot with systems and procedures for nominal and non-nominal conditions including emergency operations and abort scenarios.
    - A description of our high-g training program for each crewmember. Our training program includes training of the pilot in an aerobatic airplane to simulate the anticipated g-stresses and flight environment. BlueSky R&D program also includes drop tests of a flight vehicle from a helicopter. Such tests are designed to train the pilot on implementing our attitude recovery procedures, as well as provide each pilot with additional aeronautical experience.
    - How each pilot will be trained, in accordance with the flight rules listed in the Flight Rules section of our document, to operate the vehicle so that it will not harm the public.
    - Before each flight, the pilot will receive a pre-flight briefing on normal and abort procedures.
- The training program and records will be continuously updated and documented to include lessons learned. See Appendix C.

- The training completed by each pilot will be documented and maintained for each active pilot, and all pilot qualifications will be current before a pilot undertakes flight responsibilities. See Appendix C.

5.1.2 Environmental Control and Life Support Systems [§437.21(b)(3), §460.11]

- BlueSky Aerospace will control and monitor atmospheric conditions to sustain life and consciousness within the crew cabin of the vehicle. The capability to perform this function was described in the Environmental Control System Overview section and the Hazard Analysis section, and will provide for:

  - Monitoring and controlling the composition, which includes oxygen and carbon dioxide, and revitalization of the atmosphere to maintain safe levels for normal respiration;
  - Monitoring and controlling the pressure of the atmosphere to maintain safe levels for flight crew respiration;
  - Controlling contamination and particulate concentrations to prevent interference with the pilot's ability to operate the vehicle;
  - Monitoring and controlling the temperature of the atmosphere to maintain safe levels;
  - Monitoring and controlling the humidity of the cabin atmosphere to maintain safe levels;
  - Monitoring and controlling the ventilation and circulation of the cabin atmosphere to maintain safe levels;
  - Adequate redundant or back-up oxygen supply.
- BlueSky Aerospace has designed the crew cabin environment to mitigate the effects of vehicle decompression, as described in the Environmental Control System Overview section.

5.1.3 Smoke Detection and Fire Suppression [§437.21(b)(3), §460.13]

If the pilot detects smoke or a fire in the crew cabin, a CO2-based fire extinguisher mounted near the pilot can be used to suppress the fire. Once the extinguisher is used, the pilot must immediately abort the mission.

5.1.4 Human Factors [§437.21(b)(3), §460.15]

- Human factors engineering and crew workload analyses have been taken into account in the design of the human-machine interfaces associated with the missions and operations of our vehicle. BlueSky used the human factors design standards outlined in the "The Human Factors Design Standard" (HF-STD-001, FAA) and "Man-Systems Integration Standards" (NASA-STD-3000) documents for guidance in the design and layout of the vehicle's safety-critical displays and control human-interfaces.

- BlueSky Aerospace has made provisions for stowage of all objects in the cabin to avoid interference with the operation of the vehicle and flight crew during flight. All non-essential or non-safety critical objects will be stowed in safety containers located in the crew cabin.

5.1.5 Verification Program [§437.21(b)(3), §460.17]

N/A. There are no spaceflight participants aboard this vehicle.

5.1.6 Spaceflight Participant Training [§437.21(b)(3), §460.51]

N/A. There are no spaceflight participants aboard this vehicle.

5.1.7 Security [§437.21(b)(3), §460.53]

N/A. There are no spaceflight participants aboard this vehicle.

5.2 Information Requirements for Obtaining a Maximum Probable Loss Determination for Permitted Activities [§437.21(b)(2); Appendix A to Part 440, Part 3]

BlueSky Aerospace provided the following information in order for the FAA to determine financial responsibility and financial allocation of risk as part of a permitted launch. The information should enable the FAA to conduct a maximum probable loss determination.

5.2.1 Identification of Location For Pre-Flight and Post-Flight Operations [Appendix A to Part 440, Part 3A]

Our pre-flight operations will take place at our launch stand within the operating area. The location (latitude and longitude) of our launch stand is provided in the Key Flight-Safety Event Limitations section. The post-flight operations, as described in the Pre-Flight and Post-Flight Operations section, will take place at the landing site of the vehicle. The locations (latitude and longitude) of our nominal landing sites are provided in the Key Flight-Safety Event Limitations section.

5.2.2 Identification of Facilities Adjacent to the Location of Pre-Flight and Post-Flight Operations [Appendix A to Part 440, Part 3B]

As described in the Pre-Flight and Post-Flight Operations section, the pre-flight operations area will be located a minimum of 1,250 feet from any inhabited building. BlueSky launch stand is located 5,000 feet away from any inhabited building.

The landing sequence for the BlueSky vehicle involves the use of a parachute. Therefore, the exact latitude and longitude of each landing site may vary due to winds. All landing sites are within the operating area and are located in areas that are 15 miles or more from any inhabited buildings.

5.2.3 Maximum Personnel Not Involved in Permitted Activities That May Be Exposed to Risk During Pre-Flight and Post-Flight Operations [Appendix A to Part 440, Part 3C]

No U.S. Government or third party facilities, or U.S. Government personnel, will be exposed to risk during pre-flight and post-flight operations.

6. Vehicle Inspection [§437.21(d)]

BlueSky Aerospace will make the vehicle available to the FAA, at the convenience of the FAA, for inspection before the issuance of a permit. This inspection will allow the FAA to determine whether the vehicle is built consistent with representations in the permit application.

7. Acronyms

AST	Associate Administrator for Commercial Space Transportation
ATC	Air Traffic Control
CFR	Code of Federal Regulations
CO2	Carbon Dioxide
DOD	Department of Defense
DOT	Department of Transportation
ERC	Emergency Response Coordinator

ERT	Emergency Response Team
FAA	Federal Aviation Administration
GN2	Gaseous Nitrogen
GPS	Global Positioning System
HC	Hazard Class
IIP	Instantaneous Impact Point
IMU	Inertial Measurement Unit
LCD	Liquid Crystal Display
LOX	Liquid Oxygen
N/A	Not Applicable
NEPA	National Environment Policy Act
NOTAMS	Notices to Airmen
NTSB	National Transportation Safety Board
QD	Quantity and Distance Separation Relationships for Explosive Material
RCS	Reaction Control System
UHF	Ultra-High Frequency

Appendices

Appendix A: Details and Assumptions of the Monte Carlo Analysis

Appendix B: BlueSky Checklist and Flight Rules

Appendix C: List of Supporting Documentation

Appendix D: BlueSky Aerospace Hazard Analysis

Appendix E: BlueSky Verification Schedule

Appendix A: Details and Assumptions of the Monte Carlo Analysis

The instantaneous impact point (IIP) of the vehicle must be contained within our operating area. The proposed operating areas are large enough to contain our planned trajectories, as well as any impact locations due to random malfunction turn failures with turning rates up to ±5 deg/sec. Other failures that could cause the vehicle to exceed the boundaries of the operating area, such as inability to shutdown the engine or malfunction turns exceeding ±5 deg/sec are addressed in the Hazard Analysis section. For this vehicle, which flies a parabolic trajectory, the ground trace of the IIP is almost exactly the same as the ground trace of the flight. The operating region for this vehicle will generally be confined to a corridor that envelops the nominal ground trace by several miles on either side. However, in the event of a flight anomaly that results in a malfunction turn, the potential exists for a ground impact well outside the normal ground track corridor.

A Monte Carlo trajectory analysis was one of the methods used to help us define our operating area for this vehicle. We assumed that all anomalies occurring after the rocket engine shutdown will result either in an impact within the nominal corridor, or in a successful parachute deployment to allow a non-hazardous landing. Malfunction turns during the rocket ascent followed by an uncontrolled, high-speed impact present the greatest and most widespread risk to the public. The Monte Carlo trajectory cases assumed a random failure time during the rocket burn, followed by random pitch and yaw turning rates between –5 and +5 deg/sec. The thrust was then terminated five seconds after the initial failure time in accordance with our flight rules and the training requirements. This assumption allows the pilot five seconds to attempt to manually correct the malfunction turn before shutting down the rocket engine. The pilot can release the engine on/off Fail-Safe Switch on the center control stick at any time to shutdown the rocket engine. Once thrust is terminated, the trajectory simulation models a freefall to parachute deployment and descent to ground impact based on the parachute aerodynamics and a randomly selected statistical wind.

The impact locations determined from this Monte Carlo analysis are shown in Figure 12. Selecting an operating area that encompasses all of the impact locations determined by the Monte Carlo analysis will ensure that the vehicle will not exit the operating area. The red oval in Figure 12 depicts the operating area which encompasses all of the impact locations, and therefore is large enough to contain all dispersions from the primary flight trajectory.

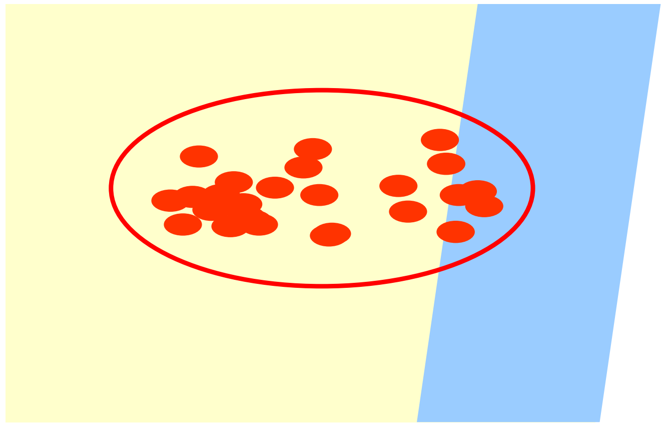

Figure 12: Operating Area for the Primary Trajectory (Flights to 328,000 ft), Determined by Impacts from Malfunction Turn Failures

Appendix B: BlueSky Checklist and Flight Rules

Pre-Ignition Checklist [Sections G-4h & H-11a]			
#	Procedure	Criteria	Action
1	Check Fuel Quantity Indicator	Confirm Fuel Quantity greater than 250 lbs	GO/NO-GO
2	Check Drogue Chute Release Indicator	Confirm Drogue Chute Release Indicator is Green	GO/NO-GO
3	Check Main Parachute Release Indicator	Confirm Main Parachute Release Indicator is Green	GO/NO-GO
4	T-5:00 prior to ignition - Clear operating area of any uninvolved people and automobile traffic	Confirm Zero uninvolved people and automobile traffic in operating area at T-5:00 prior to ignition	GO/NO-GO
5	Clear "Safety Clear Zones" around Launch Site (Pad) of people (uninvolved public)	Confirm Zero population (uninvolved public) in Safety Clear Zone	GO/NO-GO
6	Clear "Safety Clear Zones" around Landing Site of people (uninvolved public)	Confirm Zero population (uninvolved public) in Safety Clear Zone	GO/NO-GO
7	Check Real Time Communication with ATC	Confirm Real Time communication with ATC	GO/NO-GO
8	Check Engine Arm Switch is Activated	Confirm Engine Arm Switch is Activated	GO/NO-GO
9	Check RCS Arm Switch is Activated	Confirm RCS Arm Switch is Activated	GO/NO-GO
10	Check Parachute Enable Switch is Not Activated	Confirm Parachute Enable Switch is Not Activated	GO/NO-GO
11	T-5:00 prior to ignition – Check meteorological conditions	Confirm meteorological conditions is "GO" (i.e., no lightning in operating area)	GO/NO-GO
12	T-5:00 prior to ignition – Check high altitude winds launch commit criteria	Confirm high altitude winds are less than 200 ft/sec	GO/NO-GO
13	Clear "Key Flight-Safety Event Impact Point Areas" of people (uninvolved public)	Confirm Zero population (uninvolved public) in Key Flight-Safety Event Impact Point Areas	GO/NO-GO
14	Check Real Time Communication between Ground Command Station and pilot	Confirm Real Time communication between Ground Command Station and pilot	GO/NO-GO

Flight Rules [Sections G-4h & H-11b (i & ii)]		
#	**Scenario**	**Action**
1	If main engine does not ignite	ABORT Implement "Safe Vehicle" emergency procedures
2	If the vehicle's IIP is 3 miles from operating area boundary	Initiate procedure to TURN vehicle (IIP) away from boundary.
3	If fuel quantity is equal to or less than 360 pounds	ABORT
4	If oxidizer quantity is equal to or less than 830 pounds	ABORT
5	If GN_2 pressure in RCS storage tanks is equal to or less than 750 psia	ABORT
6	If RCS Thruster Chamber pressure upon firing of any thruster is equal to or greater than 50 psia	If not achieved after 3 consecutive firings, ABORT
7	If Gyro indicator light is RED	ABORT
8	If electrical power indicator light is RED	ABORT
9	If the "Cabin Pressure Gauge" of the ECS is equal to or less than 650 torr	ABORT
10	If the "Oxygen Partial Pressure Gauge" of the ECS is equal to or less than 135 torr	ABORT
11	If the "Cabin Pressure Rate of Decrease Gauge" of the ECS is equal to or greater than 25 torr/min	ABORT
12	If fire is detected in crew cabin	Pilot uses CO2-based fire extinguisher to suppress fire, ABORT
13	If pitch & yaw parameters are outside ±5 degrees from nominal for more than 5 seconds	ABORT
14	If the vehicle's IIP is over a populated or a non-sparsely populated area	Pilot will NOT initiate a key flight-safety event

In-Flight Emergency ABORT PROCEDURES

1. Main engine On/Off control – RELEASE (Thrust Terminated)
2. Main Parachute – ACTIVATE
3. LOX Dump Switch – ON

Appendix C: List of Supporting Documentation

Documentation	Description
Pilot Medical Certificate	Copy of the pilot's valid FAA 2nd-class medical certificate issued within the past 12 months prior to launch.
Pilot Certificate	FAA pilot certificate with an instrument rating demonstrating the pilot's knowledge of the NAS necessary to operate this particular vehicle.
BlueSky Training Program	• A detailed description of BlueSky's training program, including the training standards used to qualify pilots and ground crew. • A copy of the BlueSky's training records for its pilot(s). • A description of the simulator used to training each pilot.
Environmental Data	Data to analyze the environmental impacts associated with our proposed reusable suborbital rocket launches.
Mishap Response Plan	BlueSky's procedures for responding to mishaps.
Spaceport Agreements	Agreements between BlueSky and New Frontier Spaceport.

Appendix D: BlueSky Aerospace Hazard Analysis

**** S – Severity, L – Likelihood, R – Risk**

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
1A	Avionics & Guidance	Loss of vehicle's central processor/ navigation systems due to excessive environments or loss of data from one of the following components: GPS, gyro, accelerometer, altitude sensor, antenna, or telemetry system.	The consequence is possible death or serious injury to the public inside or outside the operating area.	I	C	4	- Abort procedures and training for the pilot and ground crew. - Incorporate a Fail-Safe Switch that allows the pilot to manually abort flight by cutting off the main engine. - A warning system will provide the pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are exceeded.	I	E	12	- The vehicle's central processor and navigation systems will be ground tested at expected (modeled) flight conditions. - The vehicle's central processor and navigation systems will be flight tested during our initial flight test program (prior to permitted tests). - See Appendix E for a description of our verification schedule. - A copy of our training program has been included with this application (Appendix C). - Description of abort rules are included in the following: "BlueSky Checklist and Flight Rules."

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
1B	Avionics & Guidance	Loss of GPS signal due to hardware failure or excessive environmental conditions, resulting in erroneous data being uploaded to the vehicle's navigation system.	The consequence is a reduction in the capability of this major safety-critical system to function properly.	II	B	5	- Abort procedures and training for the pilot and ground crew. - A warning system will provide the pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are exceeded. - Incorporate a Fail-Safe Switch that allows the pilot manually to abort flight by cutting off the main engine.	II	E	15	- GPS and associated hardware will be ground tested at expected (modeled) flight conditions. - GPS and associated hardware will be flight tested during our initial flight test program (prior to permitted tests). - See Appendix E for a description of our verification schedule. - A copy of our training program has been included with this application (Appendix C). - Description of abort rules are included in the following: "BlueSky Checklist and Flight Rules."
1C	Avionics & Guidance	Failure of gyro due to hardware failure or excessive environmental conditions, resulting in erroneous data being uploaded to the vehicle's navigation system.	The consequence is a reduction in the capability of the vehicle's navigation system to function properly.	II	C	6	- Redundant gyros. - Abort procedures and training for the pilot and ground crew. - A warning system will provide the pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are	II	E	15	– Gyro and associated hardware will be ground tested at expected (modeled) flight conditions. – Gyro and associated hardware will be flight tested during our initial flight test program (prior to permitted tests). – A copy of our training program has been included with this application (Appendix C). – See Appendix E for a description of our verification schedule. – Description of abort rules are

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
							exceeded. - Incorporate a Fail-Safe Switch that allows the pilot to manually abort flight by cutting off the main engine.				included in the following: "BlueSky Checklist and Flight Rules."
1D	Avionics & Guidance	Failure of accelerometer due to hardware failure or excessive environmental conditions, resulting in erroneous data being uploaded to the vehicle's navigation system.	The consequence is a reduction in the capability of the vehicle's navigation system to function properly.	II	C	6	- Redundant accelerometers. - Abort procedures and training for the pilot and ground crew. - A warning system will provide the pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are exceeded. - Incorporate a Fail-Safe Switch that allows the pilot manually to abort flight by cutting off the main engine.	II	E	15	- Accelerometer and associated hardware will be ground tested at expected (modeled) flight conditions. - Accelerometer and associated hardware will be flight tested during our initial flight test program (prior to permitted tests). - A copy of our training program has been included with this application (Appendix C). - See Appendix E for a description of our verification schedule. - Description of abort rules are included in the following: "BlueSky Checklist and Flight Rules."
1E	Avionics & Guidance	Failure of altitude sensor due to hardware failure or excessive	The consequence is a reduction in the capability	II	C	6	- Redundant altitude sensors. - Abort procedures and training for the	II	E	15	- Altitude sensor and associated hardware will be ground tested at expected (modeled) flight conditions.

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
		environmental conditions, resulting in erroneous data being uploaded to the vehicle's navigation system.	of the vehicle's navigation system to function properly.				pilot and ground crew. - A warning system will provide the pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are exceeded. - Incorporate a Fail-Safe Switch that allows the pilot to manually abort flight by cutting off the main engine.				- Altitude sensor and associated hardware will be flight tested during our initial flight test program (prior to permitted tests). - A copy of our training program has been included with this application (Appendix C). - See Appendix E for a description of our verification schedule. - Description of abort rules are included in the following: "BlueSky Checklist and Flight Rules."
1F	Avionics & Guidance	Failure of antenna due to design inadequacies or excessive environments leads to loss of data. This results in erroneous data being uploaded to the vehicle's navigation system.	The consequence is a reduction in the capability of the vehicle's navigation system to function properly.	II	C	6	- Redundant antennas - Abort procedures and training for the pilot and ground crew. - A warning system will provide the pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are exceeded.	II	E	15	- Antenna and associated hardware will be ground tested at expected (modeled) flight conditions. - Antenna and associated hardware will be flight tested during our initial flight test program (prior to permitted tests). - A copy of our training program has been included with this application (Appendix C). - See Appendix E for a description of our verification schedule. - Description of abort rules are included in the following: "BlueSky Checklist and Flight

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
							- Incorporate a Fail-Safe Switch that allows the pilot manually to abort flight by cutting off the main engine				Rules.”
1G	Avionics & Guidance	Loss of telemetry system due to hardware failure or software fault, resulting in erroneous data being uploaded to the vehicle’s navigation system.	The consequence is a reduction in the capability of the vehicle’s navigation system to function properly.	II	C	6	- Abort procedures and training for the pilot and ground crew. - A warning system will provide the pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are exceeded. - Incorporate a Fail-Safe Switch that allows the pilot manually to abort flight by cutting off the main engine.	II	E	15	- A copy of our training program has been included with this application (Appendix C). - Description of abort rules are included in the following: “BlueSky Checklist and Flight Rules.”
1H	Avionics & Guidance	Loss of flight communication system due to hardware failure, which results in a reduction in the capability of Ground	The consequence is the increased workload of a major safety-critical system.	II	C	6	- Redundant radios. - Abort procedures and training for the pilot and ground crew. - A warning system will provide the	II	E	15	- A copy of our training program has been included with this application (Appendix C). - Description of abort rules are included in the following: “BlueSky Checklist and Flight Rules.”

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
		Command Station to communicate abort commands to the pilot.					pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are exceeded. - Incorporate a Fail-Safe Switch that allows the pilot manually to abort flight by cutting off the main engine.				
2A	Flight Control Systems	The pilot's inability to follow procedures or improper pilot procedures leads to uncontrolled vehicle motion, resulting in pilot incapacitation and crash of the vehicle.	The consequence is the possible death or serious injury to the public.	I	C	4	- Each pilot will be certified to operate the vehicle based on standards developed by the BlueSky. - In addition to the training to certify the pilot, BlueSky will conduct a pre-flight briefing before each flight to verify that everyone (ground crew and flight crew) is aware of the proper procedures for the flight. - Incorporate a Fail-Safe Switch that is	I	E	12	- A copy of our training program has been included with this application (Appendix C). The number of training hours for each pilot will be recorded. -

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
							designed to shut the main engine off if the pilot is incapacitated.				
2B	Flight Control Systems	Failure to control RCS due to electrical failure resulting in loss of control and crash of the vehicle.	The consequence is the possible death or serious injury to the public.	I	D	8	- Redundant RCS electrical systems - Abort procedures training for the pilot and ground crew	I	E	12	- A copy of our training program has been included with this application (Appendix C).
2C	Flight Control Systems	Failure to control RCS due to improper procedures resulting in loss of control and crash of the vehicle.	The consequence is the possible death or serious injury to the public.	I	D	8	- Each pilot will be certified to operate the vehicle based on standards developed by the BlueSky. - In addition to the training to certify the pilot, BlueSky will conduct a pre-flight briefing before each flight to verify that everyone (ground crew and flight crew) is aware of the proper procedures for the flight.	I	E	12	- Procedures tested during rehearsals including nominal and off-nominal conditions. - A copy of our training program has been included with this application (Appendix C).
2D	Flight Control Systems	Loss of flight control display due to hardware failure or software fault,	The consequence is the possible death or	I	D	8	- Abort procedures and training for the pilot and ground crew.	I	E	12	- A copy of our training program has been included with this application (Appendix C.) - Flight control hardware will be

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
		resulting in loss of control and crash of the vehicle.	serious injury to the public.				- A warning system will provide the pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are exceeded. - Incorporate a Fail-Safe Switch that allows the pilot manually to abort flight by cutting off the main engine.				ground tested at expected (modeled) flight conditions. - Flight control hardware will be flight tested during our initial flight test program (prior to permitted tests). - See Appendix E for a description of our verification schedule. - Description of abort rules are included in the following: "BlueSky Checklist and Flight Rules."
2E	Flight Control Systems	Failure of the Fail-Safe Switch resulting in an inability to shutdown the engine. This leads to the vehicle exiting the operating area.	The consequence is the possible death or serious injury to the public.	I	D	8	- Fail-Safe Switch is designed to fail in the "off" position. The pilot must squeeze, and hold the switch down in the "on" position to control the fuel and oxidizer flow valves of the main engine.	I	E	12	- The Fail-Safe Switch will be tested during the early non-permitted testing phase of program (i.e., helicopter drop tests, etc.). - See Appendix E for a description of our verification schedule.
3A	Electrical System	Failure of primary power source (i.e., battery) due to design inadequacies or excessive environments leading to safety-	The consequence is the possible death or serious injury to the public.	I	C	4	- Dual lithium-ion batteries. Each battery is capable of providing power for all systems for the duration of the flight.	I	E	12	- A copy of our training program has been included with this application (Appendix C).

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
		critical system loss and crash of the vehicle.					- Pilot can manually switch from primary to backup battery.				
3B	Electrical System	Electrical system short circuit resulting in loss of vehicle safety-critical systems and crash of the vehicle.	The consequence is the possible death or serious injury to the public.	I	C	4	- Overload protection/circuit breakers for critical systems (avionics and guidance, flight controls, environmental controls). - A warning system will provide the pilot with audible and visual signals when safe operating ranges of safety-critical flight parameters are exceeded. - Incorporate a Fail-Safe Switch that allows the pilot to manually abort flight by cutting off the main engine.	I	E	12	- Abort procedures and training for the pilot and ground crew. - A copy of our training program has been included with this application (Appendix C).
3C	Electrical System	Electrostatic discharge (ESD) during maintenance	The consequence is the possible	I	E	12	N/A → → → Risk is acceptable				

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
		resulting in loss of components during flight and crash of the vehicle.	death or serious injury to the public.								
3D	Electrical System	Electromagnetic interference (EMI) causes failure of systems to operate in flight and crash of the vehicle.	The consequence is the possible death or serious injury to the public.	I	E	12	N/A → → → Risk is acceptable				
4A	Software and Computing Systems	Improper GPS data obtained due to calculation, logic, data, or interface errors, resulting in erroneous data being uploaded to the vehicle's navigation system.	The consequence is a reduction in the capability of the vehicle's navigation system to function properly.	II	B	5	- Abort procedures training for the pilot and ground crew. - Incorporate a Fail-Safe Switch that allows the pilot to manually abort flight by cutting off the main engine.	II	E	15	- Abort procedures training for the pilot and ground crew. - A copy of our training program has been included with this application (Appendix C). - See Appendix E for a description of our verification schedule. - Description of abort rules are included in the following: "BlueSky Checklist and Flight Rules."
4B	Software and Computing Systems	Incorrect Flight Display (LCD) data leading to vehicle leaving operating area and crash of the vehicle.	The consequence is the possible death or serious injury to the public.	I	C	4	- Ground Command Station will communicate with pilot to abort mission if IIP is less than 3 miles from boundary of operating area. - Abort procedures training for the pilot and ground crew.	I	E	12	- A copy of our training program has been included with this application (Appendix C). - See Appendix E for a description of our verification schedule. - Description of abort rules are included in the following: "BlueSky Checklist and Flight Rules." -

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
							- Incorporate a Fail-Safe Switch that allows the pilot manually to abort flight by cutting off the main engine.				
5A	Structures	Crew cabin structural failure due to design inadequacies or excessive environments resulting in a crash of the vehicle.	The consequence is the possible death or serious injury to the public.	I	D	8	- Crew cabin designed to a safety factor of 1.5 (Design Factor 1.5).	I	E	12	- The crew cabin has been acceptance tested to a safety factor of 1.2 (i.e., protoflight test factor). The following FAA/AST guidance document has been used to determine the appropriate verification safety factors for all structures: *FAA/AST Guide to Verifying Safety-Critical Structures for Reusable Launch and Reentry Vehicles.* - See Appendix E for a description of our verification schedule.
5B	Structures	Crew entry door fails to latch due to design inadequacies or excessive environments resulting in a crash of the vehicle.	The consequence is the possible death or serious injury to the public.	I	D	8	- Latching mechanism designed to a safety factor of 1.5 (Design Factor 1.5).	I	E	12	- Latching mechanism has been tested to a safety factor of 1.5 (i.e., prototype qualification test factor). The following FAA/AST guidance document has been used to determine the appropriate verification safety factors for all structures: *FAA/AST Guide to Verifying Safety-Critical Structures for Reusable Launch and Reentry Vehicles.* - See Appendix E for a description of our verification schedule.

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
5C	Structures	Crew cabin window fails due to design inadequacies or excessive environments resulting in a crash of the vehicle.	The consequence is the possible death or serious injury to the public.	I	D	8	- Structural glass (window) designed to a safety factor of 3.0 (Design Factor 3.0).	I	E	12	- The structural glass for the crew cabin has been tested (i.e. pressurized structural testing of protoflight hardware) to a safety factor of 2.0. The following FAA/AST guidance document has been used to determine the appropriate verification safety factors for all structures: *FAA/AST Guide to Verifying Safety-Critical Structures for Reusable Launch and Reentry Vehicles.* - See Appendix E for a description of our verification schedule.
5D	Structures	Structural failure due to design inadequacies or excessive environments resulting in a crash of the vehicle.	The consequence is the possible death or serious injury to the public.	I	D	8	- The main structure of the vehicle has been constructed with skin-stringer aluminum and designed to a safety factor of 1.5.	I	E	12	- The structure has been verified by both analysis and testing. The structural design is simple with easily determined load paths. It has been thoroughly analyzed for all critical load conditions. Qualification test factor for aluminum-constructed structure is 1.5. The following FAA/AST guidance document has been used to determine the appropriate verification safety factors for all structures: *FAA/AST Guide to Verifying Safety-Critical Structures for Reusable Launch and Reentry Vehicles.* - See Appendix E for a description of our verification schedule.

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
6A	Thermal Protection system	Loss of TPS capabilities leading to loss of ability to protect vehicle from thermal environments resulting in loss of safety-critical system.	The consequence is a reduction in the capability of TPS to function properly.	II	D	10	N/A → → → Risk is acceptable. Note: See Thermal System Overview.				
7A	Propulsion System	Thrust chamber burn through due to design inadequacies resulting in a vehicle explosion. The consequence is the possible death or serious injury to the public.	The consequence is the possible death or serious injury to the public.	I	D	8	- Design thrust chamber to withstand a temperature of 600 K. - The Thrust chamber is kept cooled by circulating fuel around the chamber prior to mixing with LOX.	I	E	12	- The propulsion system will be ground tested during our initial flight-test program. - See Appendix E for a description of our verification schedule.
7B	Propulsion System	Inability to shutdown propulsion system due to failure of Fail-Safe Switch leading to loss of control of the vehicle, and the vehicle leaving the operating area.	The consequence is the possible death or serious injury to the public.	I	C	4	- See "Flight Control Systems" failure of the Fail-Safe Switch. - The pilot is trained to open the oxidizer dump ports to dump the oxidizer from the vehicle.	I	E	12	- See Appendix E for a description of our verification schedule. - A copy of our training program has been included with this application (Appendix C).

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
7C	Propulsion System	Fuel leak from line rupture or fitting failure leading to possible fire or explosion of the vehicle.	The consequence is the possible death or serious injury to the public.	I	D	8	- The fuel lines have been designed to a safety factor of 4.0. - Incorporate a Fail-Safe Switch. Allows the pilot manually to abort flight by cutting off the main engine. - Abort procedures training for the pilot and ground crew.	I	E	12	- The fuel lines have been tested to a safety factor of 1.5. The following FAA/AST guidance document has been used to determine the appropriate verification safety factors for all structures: *FAA/AST Guide to Verifying Safety-Critical Structures for Reusable Launch and Reentry Vehicles.* - See Appendix E for a description of our verification schedule. - A copy of our training program has been included with this application (Appendix C).
7D	Propulsion System	LOX leak from line rupture or fitting failure leading to possible fire or explosion of the vehicle.	The consequence is the possible death or serious injury to the public.	I	D	8	- The LOX lines have been designed to a safety factor of 4.0. - Incorporate a Fail-Safe Switch. Allows the pilot to manually abort flight by cutting off the main engine. - Abort procedures training for the pilot and ground crew.	I	E	12	- The LOX lines have been tested to a safety factor of 1.5. The following FAA/AST guidance document has been used to determine the appropriate verification safety factors for all structures: *FAA/AST Guide to Verifying Safety-Critical Structures for Reusable Launch and Reentry Vehicles.* - See Appendix E for a description of our verification schedule. - A copy of our training program has been included with this application (Appendix C).

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
7E	Propulsion System	Over pressurization of fuel tank due to improper pressurization (design inadequacies, pressurization system failure) leading to tank bursting and loss of vehicle.	The consequence is the possible death or serious injury to the public.	I	D	8	- The tank has been designed to a safety factor (burst) of 1.5. - Incorporate a Fail-Safe Switch. Allows the pilot manually to abort flight by cutting off the main engine. - Abort procedures training for the pilot and ground crew.	I	E	12	- The tank has been proof tested to a safety factor of 1.25. The following FAA/AST guidance document has been used to determine the appropriate verification safety factors for all structures: *FAA/AST Guide to Verifying Safety-Critical Structures for Reusable Launch and Reentry Vehicles.* - See Appendix E for a description of our verification schedule. - A copy of our training program has been included with this application (Appendix C).
7F	Propulsion System	Over pressurization of LOX tank due to improper pressurization (design inadequacies, pressurization system failure) leading to tank bursting and loss of vehicle.	The consequence is the possible death or serious injury to the public.	I	D	8	- The tank has been designed to a safety factor (burst) of 1.5. - Incorporate a Fail-Safe Switch. Allows the pilot to manually abort flight by cutting off the main engine. - Abort procedures training for the pilot and ground crew.	I	E	12	- The tank has been proof tested to a safety factor of 1.25. The following FAA/AST guidance document has been used to determine the appropriate verification safety factors for all structures: *FAA/AST Guide to Verifying Safety-Critical Structures for Reusable Launch and Reentry Vehicles.* - See Appendix E for a description of our verification schedule. - A copy of our training program has been included with this application (Appendix C).

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
7G	Propulsion System	Failure of engine to re-ignite during landing due to inadequate design or excessive environments resulting in lost of vehicle.	The consequence is not serious enough to cause injury to the public.	IV	C	18	N/A → → → Risk is acceptable				
7H	Propulsion System	Loss of reaction control system due to line failure resulting in the crashing inside or outside operating area.	The consequence is the possible death or serious injury to the public.	I	D	8	- Incorporate a Fail-Safe Switch. Allows the pilot manually to abort flight by cutting off the main engine. - Abort procedures training for the pilot and ground crew.	I	E	12	- A copy of our training program has been included with this application (Appendix C).
7I	Propulsion System	Excessive use or loss of RCS gaseous N2 due to inadequate design or excessive environments resulting in the vehicle crashing inside or outside operating area.	The consequence is the possible death or serious injury to the public.	I	D	8	- Incorporate a Fail-Safe Switch. Allows the pilot manually to abort flight by cutting off the main engine. - Abort procedures training for the pilot and ground crew.	I	E	12	- A copy of our training program has been included with this application (Appendix C).
7J	Propulsion System	Propellant dump valve fails to open leading to possible fire and explosion if hard landing and fuel on board.	The consequence is not serious enough to cause injury to the public.	IV	D	19	N/A → → → Risk is acceptable				

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
8A	Landing System	Partial or full failure of parachute due to inadequate design or excessive environments resulting in the vehicle crashing inside or outside operating area.	The consequence is the possible death or serious injury to the public.	I	C	4	- Redundant release mechanisms. - Extensive pilot training for this emergency situation will be conducted before the piloted test flights begin. - Abort procedures training for the pilot and ground crew.	I	E	12	- A copy of our training program has been included with this application (Appendix C).
8B	Landing System	Partial or full failure of landing gear leads to vehicle crashing.	The consequence is not serious enough to cause injury to the public.	IV	D	19	N/A → → → Risk is acceptable				
9A	Vehicle Environmental Control	Loss of cabin pressure due to explosion, overpressure, puncture, or gradual leak results in pilot incapacitation and an uncontrolled crash.	The consequence is the possible death or serious injury to the public.	I	D	8	- Gauge for cabin pressure in crew cabin. - Dual pressurized tanks. The pilot can manually switch between tanks in an emergency. This system will be tested and inspected prior to each flight. - Extensive pilot training for this emergency situation will be conducted	I	E	12	- A copy of our training program has been included with this application (Appendix C). - See Appendix E for a description of our verification schedule.

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
							before the piloted test flights begin. - Incorporate a Fail-Safe Switch. Allows for an automated abort by cutting off the main engine if pilot is incapacitated.				
9B	Vehicle Environmental Control	Failure of the CO2 scrubber systems due to design inadequacies leading to pilot incapacitation and probable crash of the vehicle inside or outside the operating area.	The consequence is the possible death or serious injury to the public.	I	D	8	- Redundant CO2 scrubbing systems. - Dual pressurized tanks. The pilot can manually switch between tanks in an emergency. This system will be tested and inspected prior to each flight. - Incorporate a Fail-Safe Switch. Allows for an automated abort by cutting off the main engine if pilot is incapacitated.	I	E	12	- See Appendix E for a description of our verification schedule.
9C	Vehicle Environmental Control	Failure of one or more fans to circulate cabin air due to design inadequacies leads CO2 buildup	The consequence is the possible death or serious injury to the public.	I	D	8	- Redundant dehumidifier fan. - Dual pressurized tanks. The pilot can manually switch between tanks in an	I	E	12	- See Appendix E for a description of our verification schedule.

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
		resulting in pilot incapacitation probable crash of the vehicle inside or outside the operating area.					emergency. This system will be tested and inspected prior to each flight. - Incorporate a Fail-Safe Switch. Allows for an automated abort by cutting off the main engine if pilot is incapacitated.				
9D	Vehicle Environmental Control	Loss of pressurized air for crew breathing due to design inadequacies leads to pilot incapacitation and probable crash of the vehicle inside or outside the operating area.	The consequence is the possible death or serious injury to the public.	I	D	8	- Dual pressurized tanks. The pilot can manually switch between tanks in an emergency. This system will be tested and inspected prior to each flight. - Incorporate a Fail-Safe Switch. Allows for an automated abort by cutting off the main engine if pilot is incapacitated.	I	E	12	- See Appendix E for a description of our verification schedule.
9E	Vehicle Environmental Control	Fire/smoke in crew cabin resulting in pilot incapacitation and probable crash of the vehicle inside or outside the	The consequence is the possible death or serious injury to the public.	I	D	8	- Redundant CO2 scrubbing systems. - Dual pressurized tanks. The pilot can manually switch between tanks in an	I	E	12	- A copy of our training program has been included with this application (Appendix C). - See Appendix E for a description of our verification schedule.

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
		operating area.					emergency. This system will be tested and inspected prior to each flight. - Abort procedures training for pilot and ground crew. - CO2-based suppression system. - Incorporate a Fail-Safe Switch. Allows for an automated abort by cutting off the main engine if pilot is incapacitated.				
10A	Natural Environments	The vehicle experiences wind gusts exceeding 200 ft/sec. This results in the pilot and the flight control system inability to control the vehicle. Probable crash of the vehicle inside or outside the operating area.	The consequence is the possible death or serious injury to the public.	I	C	4	- Wind limits on launch commit criteria.	I	E	12	- Description of abort rules are included in the following: “BlueSky Checklist and Flight Rules.”
10B	Natural Environments	Natural or triggered lightning strikes the vehicle in flight leading to flight -	The consequence is the possible crash of the	II	C	6	- Monitor and report meteorological conditions to the mission conductor	II	E	15	- Description of abort rules are included in the following: “BlueSky Checklist and Flight Rules.”

No.	System	Hazard Description	Results	**Risk Before Mitigation Measures			Risk Elimination or Mitigation Measures	**Risk After Mitigation Measures			Verification Evidence
				S	L	R		S	L	R	
		safety system malfunction.	vehicle outside operating area.				prior to launch. - Vehicle will not launch if lightning producing meteorological conditions exist.				

Appendix E: BlueSky Verification Schedule

No.	System	Purpose	Test Description	Test Dates	Available Products for Delivery
1	Avionics & Guidance	To verify the operation of the central processor/ navigation system under a range of conditions: – Due to excessive load environments – Loss of data from the GPS, gyro, accelerometer, altitude sensor, antenna, or telemetry system	Ground Tests: 10 Attach central processor/navigation system to shaker and vibrate system at expected flight conditions. Perform functionality tests before and after each test.	Nov 2006 – Jan 2007	- Avionics and Guidance test data and results - Flight Test #1 results document
			Flight Tests: 4 Central processor/ navigation system will be integrated into test vehicle and dropped from a helicopter during non-permitted flights to test its functionality. These tests will be performed during Flight Test #1 as described in Table 1.		
2	Flight Control Systems	To verify the ability of the pilot to use the flight control systems and displays to control the vehicle during normal operations and emergency situations	Ground Tests Without Pilot: 10 Vehicle will be mounted on a special sled that can move laterally in both the x- and y-direction. The sled also contains sensors to measure forces in the z-direction. With the vehicle mounted on the sled and the various RCS thrusters firing, the vehicle will either move in the x-y plane or will register the level of force in the z-plane. To ensure safety to the pilot, this first set of tests will be conducted using the remote control to control the movement of the sled and vehicle.	Jan – Apr 2007	- Flight Control Systems test data and results - Video of multiple Ground Tests
			Ground Tests With Pilot: 10 Same as above ground tests, but with the pilot inside the vehicle controlling the sled and vehicle.		
			Flight Tests: 6 Vehicle will be dropped from 10,000 ft from a helicopter during non-permitted flights, with the pilot controlling the vehicle from inside the vehicle. These tests will be performed during Flight Test #3 as described in Table 1.	Apr – May 2007	- Flight Control Systems tests data and results from Flight Test #3 - Video of multiple tests during Flight Test #3

No.	System	Purpose	Test Description	Test Dates	Available Products for Delivery
3	Electrical System	To verify the operation of the electrical system under a range of conditions: - Due to excessive load environments - Loss of system from short circuit, ESD, or EMI	Ground Tests: 10 Attach electrical system to shaker and vibrate system at expected flight conditions. Perform functionality tests before and after each test.	Nov 2006 – Jan 2007	- Electrical System Ground tests results
			Flight Tests: 3 Electrical system will be integrated into test vehicle and dropped from a helicopter during non-permitted flights to test its functionality. These tests are a subset of Flight Test #1 as described in Table 1.	Feb – Mar 2007	- Tests results from Flight Test #1
			Flight Tests: 3 Vehicle will be dropped from 10,000 ft from a helicopter during non-permitted flights, with the pilot controlling the vehicle from inside the vehicle. These tests are a subset of Flight Test #3 as described in Table 1. During three of the tests, the pilot will test abort and training procedures, focusing on the electrical system.	Apr – May 2007	- Tests results from Flight Test #3
4	Software and Computing Systems	To verify that proper GPS and flight display data is obtained and relayed to the pilot	Ground Tests: 10 During the sled tests with the pilot in the vehicle described above (No. 2, Flight Control Systems), the pilot will test and confirm the GPS and flight display data delivery.	Feb – Apr 2007	- Software and Computing Systems Ground tests results
			Flight Tests: 6 During Flight Tests #3, as described in Table 1, the pilot will continue to test and confirm the GPS and flight display data delivery.	Apr – July 2007	- Tests results from Flight Test #3
5	Structure	To verify the integrity of the structures of the vehicle under a range of conditions: - Due to excessive load environments - Due to design inadequacies	Ground Tests: 5 Attach vehicle to shaker and vibrate at expected flight conditions. Perform functionality tests before and after each test.	Nov– Dec 2006	- Structural tests results
			Flight Tests: 4 Vehicle will be dropped from a helicopter during non-permitted flights to test structural integrity. These tests are a subset of Flight Test #1, as described in Table 1.	Feb – Mar 2007	- Structural tests results from Flight Test #1

No.	System	Purpose	Test Description	Test Dates	Available Products for Delivery
6	Thermal Protection System	To verify the integrity of the thermal protection system under a range of conditions: – Due to excessive load environments – Due to excessive heating	Ground Tests: 5 Attach test article, with thermal protection system, to shaker and vibrate at expected flight conditions. Perform functionality tests before and after each test.	Nov–Dec 2006	- Thermal Control System tests results
			Ground Tests: 5 Apply heat to thermal protections system. Perform functionality tests before and after each test.	Dec 2007 – Jan 2006	- Thermal Control System tests results
7	Propulsion System	To verify the integrity of the propulsion components (thrust chambers, fuel lines, tanks, valves) of the vehicle under a range of conditions: – Due to excessive load environments – Due to design inadequacies	Ground Tests: 5 The propulsion system will be statically fired to test the integrity and functionality of engine.	Nov–Dec 2006	- Propulsion System ground tests results
			Flight Tests: 4 Vehicle will be dropped from a helicopter during non-permitted flights to test integrity of propulsion components, excluding main rocket engine. These tests are a subset of Flight Test #1, as described in Table 1.	Feb – Mar 2007	- Flight Test #1 Propulsion System tests results
			Flight Tests: 6 Vehicle will be dropped from a helicopter during non-permitted flights to test integrity of propulsion components, with main rocket engine. These tests are a subset of Flight Test #3, as described in Table 1.	Apr – May 2007	- Flight Test #3 Propulsion System tests results
8	Landing System	To verify the operation of the parachute and landing gear	Ground Test: 5 The landing gear deployment mechanisms, as well as the capability of the landing gear to sustain the landing loads upon landing, will be tested. The tests will encompass attaching the landing gear to a tether and dropping it to simulate nominal and off-nominal landings.	Dec 2006	- Landing system ground tests results
			Flight Tests: 4 Vehicle will be dropped from a helicopter during non-permitted flights to test parachute and deployed landing gear. These tests are a subset of Flight Test #1, as described in Table 1.	Feb – Mar 2007	- Flight Test #1 Landing System tests results
			Flight Tests: 6 Vehicle will be dropped from a helicopter during non-permitted flights to test deployment of landing gear. These tests are a subset of Flight Test #3, as described in Table 1.	Apr – May 2007	- Flight Test #3 Landing System tests results

No.	System	Purpose	Test Description	Test Dates	Available Products for Delivery
9	Vehicle Environmental Control	To verify the integrity of the environmental control components (cabin, CO2 scrubber, fans, pressurization system) of the vehicle under a range of conditions: Due to excessive conditions (i.e., CO2 buildup, fire/smoke, pressure drop/increase, etc.) Due to design inadequacies	Ground Tests: 5 Pressurize the cabin and perform functionality tests and analysis of the environmental control system, including the use of our fire suppression system.	Nov–Dec 2006	- Environmental Control System tests results
			Flight Tests: 4 Vehicle will be dropped from a helicopter during non-permitted flights to test integrity of environmental control components. These tests are a subset of Flight Test #1, as described in Table 1.	Feb – Mar 2007	- Flight Test #1 tests data and results - Environmental Control System tests results
10	Natural Environments	To verify that the pilot has been trained to the abort procedures described in our Flight Rules	BlueSky will simulate the vehicle's response to off-nominal wind conditions. This training will assess the pilot's response to abort conditions.	Feb – Mar 2007	- Results of the pilot's training/simulation