X PRIZE Team Summary Sheet
PANAERO

All the information given in this document has been cleared for official release by the X PRIZE Foundation and the PanAero team. Quotes provided by PanAero are shown in italics. For more information about PanAero or if you have questions about PanAero, please visit their web site at www.tour2space.com.

TEAM OVERVIEW

PanAero, Inc. is a Nevada corporation formed for the purpose of providing engineering support for Third Millennium Aerospace, Inc. and for competing for the X PRIZE. Currently, PanAero, Inc. is responsible for converting an F-14 into a first-stage reusable launch vehicle as a Phase I, second-tier contractor for the DoD/DARPA Responsive Access Small Cargo Affordable Launch Program under a DARPA contract to Coleman Aerospace.

TEAM LEADER BACKGROUND

From 1943 to 1967, Len Cormier served as a Naval Aviation cadet, Navy carrier-based fighter pilot, and executive officer of an ASW patrol squadron on active duty and in the Naval Reserve. Len began his career in the space business at the National Academy of Sciences in 1956 and at NASA headquarters in 1959. In the early and mid 1960s, he was project engineer for space transportation systems at the Los Angeles Division of North American Aviation, Inc. Len was a charter member and a reappointed member of the Dept. of Transportation's Commercial Space Transportation Advisory Committee (COMSTAC).

DATA AT-A-GLANCE

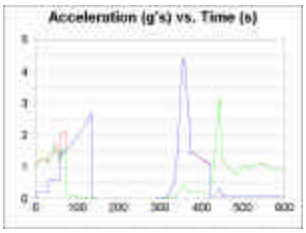
TEAM SPECIFICATIONS

- Name: PanAero
- Leader: Len Cormier
- Home: Fairfax, Virginia, USA
- Registered with X PRIZE: 8 April 1997
- Web: www.tour2space.com

VEHICLE SPECIFICATIONS

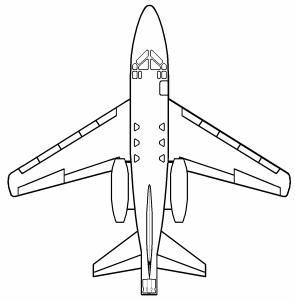
- Name: SabreRocket
- Length: 13.75 m
- Span: 13.53 m
- GTOW: 11,900 kg
- Dry Weight: 5,700 kg
- Crew Capsule: Pressurized cockpit
- Cabin Pressurization: 18,000 feet
- Crew Environment: Pressurized cabin and oxygen masks
- Payload Capacity: 300 kg
- No. of Engines: 7 (Microcosm)
- Propulsion System: Pressure fed ablative
- Fuel: Kerosene
- Oxidizer: Liquid Oxygen
- Total Thrust: 7 engines at 5,100 lb_f each
- Reaction Control System: Cold gas helium

MISSION SPECIFICATIONS



- Ascent Method to Ignition Alt.: Turbojet aerodynamic flight
- Ascent Duration: ~20 minutes
- Alt. at Ignition: 11 km
- Orientation at Ignition: Horizontal for first engine, pulling up to 85 degrees pitch up with all engines.
- Max. Accel. Force on Ascent: 2.7 g
- Alt. at Engine Cut-off: 54 km
- Time at Engine Cut-off: ~150 sec after ignition
- Max. Speed: 2.97 M
- Max. Altitude: 102 km
- Time in Weightless Conditions: ~180 sec
- Reentry Method: “Belly Flop” (70 degree angle of attack)
- Accel. Forces on Descent: 4.4 g
- Landing Method: Horizontal on runway
- Total Duration: approximately 40 minutes
- Landing Distance from Take-off Location: 0 km
- Time Between Missions: Could be hours (to allow for vehicle inspection and refueling)

VEHICLE/LAUNCH SYSTEM DESCRIPTION



PanAero will modify a currently existing Sabre-40 that is currently certified for a takeoff gross mass of 8,634 kg. The primary limitation on higher gross mass for experimental use is the load on the landing gear at take-off as well as available thrust. To accommodate an overweight takeoff condition, the landing gear could be strengthened, 20 seconds of rocket power may be used on takeoff, or powered auxiliary gear for takeoff may be devised.

Primary modifications to the existing jet includes the addition of the cluster of seven Microcosm engines, a reaction control system for control outside of the atmosphere, batteries, and a stored air system to maintain pressurization when the jet engines are inoperative.

The Sabre-40 is a relatively strong business jet capable of 3.5 g at 7,650 kg gross mass. The Sabreliner was initially derived from the F-86 Sabrejet fighter and the T-39 military trainer. While most other business jets are designed for only 2 g, the SabreRocket will not experience more than 4.4 g on reentry at perhaps 50 percent of the takeoff gross mass. Accordingly, the wing will be able to withstand 4.5 g at a burnout mass of 5,900 kg. Despite this, engine mounts and landing-gear up-locks will need to be reinforced.

The wings protect the air breathing engine inlets during reentry at high angles-of-attack. Out gassing of the engine lubricants will not present any problems because the time above the atmosphere is only about three minutes.

The SabreRocket's existing pressurized cabin will be supplemented by an oxygen mask for the pilot. Normally, the cabin pressure in space should be equivalent to about 5500 m (18,000 ft). Bleed air will provide cabin pressurization below 13,700 km and stored oxygen/argon, or oxygen/nitrogen, provides pressurization for higher altitudes.

PROPULSION SYSTEM

The SabreRocket will be equipped with seven (7) Microcosm engines arranged in circle of six engines around a single engine in the center. Each engine produces a sea level thrust of about 4,374 lb_f (19,457 Newtons). Vacuum thrust with the existing nozzles is 5,113 lb_f (22,744 Newtons) per engine, providing an initial thrust-to-weight ratio of about 1.5:1 when all of the rocket engines are ignited, including a small amount of residual thrust from the jet engines prior to flame-out in very thin air.

The high-pressure (3.5 MPa, 500 psi), non-integral propellant tanks are available from Microcosm and will be carried inside the cabin.

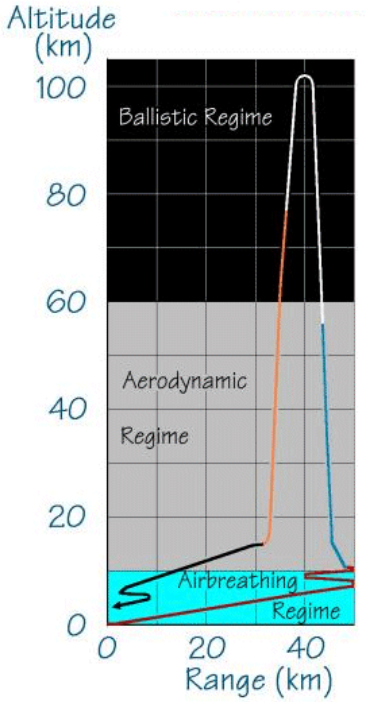
The reaction control system is also available from Microcosm. It uses helium gas from the otherwise empty, pressurized propellant tanks.

MISSION DESCRIPTION

The SabreRocket will achieve the 100 km altitude with a single stage system, a modified Sabre-40 jet. This aircraft, already certified to fly at mach 0.8 at 45,000 ft (13,716 meters) will be modified to perform the flight profile described below.

VEHICLE ASCENT

The take-off and climb of the SabreRocket will only use the existing air breathing turbojet engines until the altitude of 11 km. At this time, the pilot ignites the center rocket engine and starts a pull-up and climb. After about 30 seconds, the pilot starts two more rocket engines, increasing the climb angle to about 50 degrees. At about 15.5 km altitude, the pilot starts the remaining four rocket engines and continues the pull-up to an 85 degree flight-path angle. At the time when all the rocket propellant is consumed, the SabreRocket will have reached a



speed of mach 2.97 at an altitude of approximately 54 km altitude.

WEIGHTLESSNESS

From an altitude of 55 km and a speed of mach 2.97, it takes the SabreRocket approximately 100 seconds to coast past the 100-km altitude limit at a speed of approximately mach 0.4. The vehicle reaches the apogee of its flight at an altitude of 102 km and then begins it free fall descent.

For approximately another 80 seconds, the SabreRocket descends unpowered. The total time the crew and passengers experience weightless conditions is approximately 180 seconds.

VEHICLE DESCENT AND LANDING

Using the attitude control system, the pilot reenters the atmosphere at an 85 or 90 degree flight-path angle and an angle-of-attack of 70 degrees. In this attitude, the wings act as a parachute or drag brake. For this phase of the flight, the wing is much more effective at generating drag than lift. This technique will minimize mach number on reentry and will also minimize the reentry g's and heating. Preliminary calculations suggest that provisions required for thermal protection during the transient heating period should be minimal.

HARDWARE & TESTS

PanAero currently has scale models of the SabreRocket. A potential Sabreliner aircraft has been identified which can be purchased and modified to accomplish the SabreRocket flights.

There are no full-scale engineering mock-ups or prototypes of the SabreRocket.

The incremental flight test program to validate the proposed flight profile will require approximately twenty flights.

Multiple rocket engines will be used for these flight tests. The flight experience of the Microcosm engines includes two successful flights and no failures. Although they have not been previously certified for manned flight, PanAero feels that these engines are suitable for an X PRIZE flight attempt without passengers aboard.

PUBLICITY

PERSONAL APPEARANCES

PanAero plans personal appearances at air shows and other publicity and sponsorship-related events once the funding to acquire the Sabre-40 has been achieved.

TELEVISION

Len Cormier appeared on "Around Space", a 30 minute interview series sponsored by the L-5 Society and the Fairfax Public Access Cable Channel 10. The show first aired in the Washington, D.C. area in June 2002 and was repeated frequently. It will be rebroadcast throughout the country at various times.

PRINT MEDIA

PanAero was featured in an article entitled "The X Prize" which appeared in the July 2002 issue of Discover Magazine.

TEAM BACKGROUND

TEAM MEMBERS

- Pat O'Briant, Deputy Project Engineer / Deputy Project Manager
- Bill Franklin, Structures and Configuration Engineer
- James Jason Wentworth, Program Development Agent
- Pat Kelley, Vela Technology Development Inc.
- Bob Ballard, Vela Technology Development Inc.
- John Powers, Vela Technology Development Inc.
- Lee Lunsford, Vela Technology Development Inc.
- Rick Jurmain, Vela Technology Development Inc.

X PRIZE QUOTE

"The X PRIZE provides a potentially powerful incentive for opening space to commercial competition and development. Our concept appears to be feasible with far lower investment than any of the other concepts proposed for winning the X PRIZE. Accordingly, we feel that we can offer a

potentially leveraged return on investment based solely upon potential revenues from sponsors and possibly the prize money. Like the other teams, we also feel that even a good showing with respect to competing for the X PRIZE could be highly beneficial to our other plans of commercial opportunities in near Earth orbit and deep space."
– Len Cormier

PHILOSOPHY

"The long-term plan is, of course, to service the space tourism market. In this respect, the SabreRocket should be an effective tool for convincing the financial community that there is minimal risk in building and operating spaceships capable of carrying commercial passengers. If the only result of building and flying the SabreRocket is the opening of traditional Wall Street funding sources for a second round of financing to create a robust fleet of space tourism vehicles, it should be considered a success." – Len Cormier

MISSION AND GOALS

"We believe that we can make a very good try for the X PRIZE. We hope to fund this project through some combination of investors and/or sponsors and/or sponsor-investors. Once available, our modified Sabreliner - or SabreRocket, as we call it - may have other revenue-producing applications. However, these additional applications - particularly the carrying of passengers on sub-orbital adventure rides to space - will likely require substantial additional development and testing."
– Len Cormier

X PRIZE FOUNDATION

Below is contact information for the X PRIZE Foundation.

MAILING ADDRESS

722A Spirit of St. Louis Boulevard
Chesterfield, Missouri, USA 63005

PHONE NUMBERS

Office: +1 314-533-2002
Fax: +1 314-533-6502

INTERNET

Email: info@xprize.org
Web: www.xprize.org