# X PRIZE Team Summary Sheet
# CANADIAN ARROW

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

## TEAM OVERVIEW

The Canadian Arrow team is highly motivated to fulfill the dream of popular space travel using the "don't reinvent the wheel" approach. By making use of the research performed over 60 years ago, this Canadian team plans to bring the V2 rocket back to life, but this time for the benefit of the space tourism industry.

### TEAM LEADER BACKGROUND

Geoffrey Sheerin is an industrial designer with proven skills in managing large technical projects. He has invented, patented, developed, and marketed advanced heat transfer equipment for use in cooling large scale electrical equipment. His achievements include concept designs for robotic equipment used in hazardous environments, and the design and development of equipment used in the photo industry. Geoff is well versed in the technology of launch vehicles and space flight.

Short biographies of the rest of the team members are given later in this document.

## DATA AT-A-GLANCE

### TEAM SPECIFICATIONS

- Name: Canadian Arrow
- Leader: Geoffrey Sheerin
- Place: London, Ontario, Canada
- Registered with X PRIZE: 8 November 2000
- Web: www.canadianarrow.com

### VEHICLE SPECIFICATIONS

- Name: Canadian Arrow
- Description: Two stage rocket design based on German V2
- Length ($1^{st}$, $2^{nd}$ Stage): 54 feet (33.5 feet, 20 feet)
- Diameter: 5.4 feet
- GTOW: 31,000 $lb_m$
- Dry Weight: 12,500 $lb_m$
- Crew Capsule Environment: Pressurized to 1 atm plus full pressure suits for crew
- Payload Capacity: 3 passengers (900 $lb_m$)
- No. of Engines ($1^{st}$, $2^{nd}$ Stage): 1, 4
- Propulsion System ($1^{st}$, $2^{nd}$ Stage): Liquid Pressure Fed, Solid
- Fuel, Oxidizer, $1^{st}$ Stage: Alcohol, Liquid Oxygen
- Fuel, Oxidizer, $2^{nd}$ Stage: a blend of perchlorate, asphalt, and special oils
- Total Thrust ($1^{st}$, $2^{nd}$ Stage): 57,000 $lb_f$, 17,600 $lb_f$
- Reaction Control System: Cold gas nitrogen

### MISSION SPECIFICATIONS

- Launch Sites: Any coastal area with open water at least 100 ft deep, with a range footprint of 40 by 30 miles
- Alt. at Ignition: Launch from Earth surface
- Orientation at Ignition: Vertical
- Max. Accel. Force on Ascent: 5.4 g for 3 sec
- Alt. at Engine Cut-off: 112,000 feet
- Time at $1^{st}$ Stage Engine Cut-off: 60 sec
- Max. Speed:
- Max. Altitude:
- Time in Weightless Conditions: 4 minutes
- Reentry Method: Ballistic descent
- Accel. Forces on Descent: 7.5 g for 3 sec
- Landing Method: Parachute descent into ocean.
- Total Duration: 45 minutes
- Landing Distance from Take-off Location: 15 miles downrange
- Time Between Missions: 10 days

# VEHICLE/LAUNCH SYSTEM DESCRIPTION

The Canadian Arrow is a 54-ft long, two-stage, three person sub-orbital rocket with the second stage doubling as an escape system. The first stage is 33.5 ft. long and 5.4 ft. in diameter with four fins at the base for aerodynamic stability.

Steering of the vehicle is accomplished using graphite jet vanes and aerodynamic flaps on the fins. The second stage (crew cabin) is 20-ft. long and 5.4 ft. in diameter at the base, and contains four jet-assisted-take-off type rocket engines for second stage propulsion.

The four solid rockets can be ignited at any point during the flight, including before launch, to initiate a zero altitude launch pad abort or an in-flight recovery sequence.

For a zero altitude abort, the crew cabin will reach a height of 5,000 feet where it will deploy its 3 main recovery parachutes. All of the hatches on the crew cabin can be explosively blown off for quick exit of the vehicle.

For an in-flight abort, four extendable fin plates stored behind panels at the rear of the cabin will deploy to provide flight stability, similar to the type used on Russian launch abort systems.

The Canadian Arrow sub-orbital vehicle is designed for water splashdown recovery. Due to this requirement, the launch site must have open water at least 100 ft deep, with a range footprint of 40 by 30 miles. This size of footprint will accommodate in-flight abort situations and range safety destruction of the first stage. Any coastal area is a potential launch site for the Canadian Arrow. It is preferable to use established launch sites that offer tracking and other vehicle processing services. Potential sites include areas such as the Churchill Launch Range, in northern Manitoba, Canada, and the Virginia Space Flight Center, USA.

## PROPULSION SYSTEM

The Canadian Arrow first stage uses a reproduction WWII thrust chamber. Burning a mixture of alcohol and liquid oxygen, this motor will produce 57,000 pounds of thrust at sea level. The engine is constructed of low carbon steel with propellant injectors made from brass. The first stage propellants are fed to the engine using a pressurized nitrogen gas system. This system is made up of two propellant tanks for fuel and oxidizer, topped by a single composite construction high-pressure gas sphere.

The second stage of the Canadian Arrow is propelled by 4 jet assisted take-off type solid rocket engines. The four engines are ignited simultaneously just after stage separation.

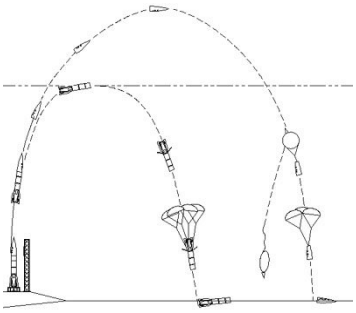
The guidance system maintains correct attitude control using cold gas jets.

# MISSION DESCRIPTION

## VEHICLE ASCENT

The vehicle arrives at the launch pad 4 hours before launch. After vehicle checkout, the propellants are loaded, and chill down of cryogenic components begins. Final wet checkout is performed, and the flight crew enters the crew cabin approximately 30-min before launch.

After launch countdown, the propellant valves are opened, allowing the propellants to flow under gravity into the combustion chamber. Ignition occurs, initially producing only 17,000 lbs. of thrust. The tanks are then brought up to full pressure, and the engine now builds rapidly to full thrust, lifting the vehicle from the launch pad. Graphite vanes in the exhaust gas ensure a stable flight until enough speed has been built up to allow the aerodynamic fins to function. The first stage burns for just under one minute, until all of the propellant is exhausted.



Just prior to engine cutoff, the occupants will experience acceleration of no more than 4.5 g. At the edge of space, the second stage separates and ignites its engines, boosting the velocity enough to reach 70 miles altitude.

The pilot can use the cold gas jets to orient the second stage to provide the best window view for the passengers.

### VEHICLE DESCENT AND LANDING

After separation, the first stage follows a trajectory that carries it over 50 miles high. Recovery of the first stage is initiated by using four "air brake flaps" located between each fin on the tail section. These air brakes will slow the first stage as it descends through the atmosphere. Four main parachute packs are stored directly behind each air brake panel, and these packs are ready to deploy after each air brake opens. Small solid propellant rockets pull out pilot chutes that deploy the main chutes. Each main parachute is 64 ft. in diameter and will slow the second stage for a splashdown on water at approximately 30 ft/sec. The first stage has positive buoyancy eliminating the need for flotation gear. A recovery ship will lift the booster from the water and carry it back to base for processing and re-launch.

Upon reentry of the second stage, the dive brakes situated between the fins open to maintain a stable attitude and decelerate the vehicle to subsonic speed. As the crew cabin decelerates into the denser atmosphere, the ballute ram air scoops keep it inflated to the correct pressure.

When the booster reaches the lower, denser atmosphere during the reentry phase of the flight, the nose cap will separate from the main cabin, pulling out the ram air reentry ballute. This ballute will slow down and stabilize the crew cabin during the reentry phase of the flight. Stored just under the ballute are three parachutes 50 feet in diameter that, when deployed, reduce the crew cabin splashdown velocity to 26 ft/sec. Splashdown will occur in the water approximately 15 miles down range from the launch site.

The crew cabin has a low center of gravity so that when floating on the water, the cabin will roll over to a stable position with the hatches facing up. After reorienting itself, inflatable floats are deployed on each side of the cabin to make the whole craft a very stable 'raft' on the water. The crew can now open the hatches and stand up if they want to, while waiting for the recovery vessel.

## HARDWARE & TESTS

The Canadian Arrow team has constructed a full-scale engineering mock-up of the Canadian Arrow rocket.

Hardware for the propulsion system has also been built and tested.

- A successful hot-fire test of the main engine injector cup was conducted on 25 July 2002.
- A full-scale, hot-fire test of the 57,000 pound thrust main engine is projected to take place before the end of 2002.

## PUBLICITY

The following publicity was generated during the four days between 23 and 26 April, 2002.

### PERSONAL APPEARANCES

- Displayed Canadian Arrow full-scale mock-up at Rockefeller Plaza in New York City, USA.

### TELEVISION AND RADIO

- 23 April 2002, appeared on NBC “Today” show, plus 3 hours of live drop-ins from Rockefeller Plaza in New York City, USA.
- CNN Network News, USA
- MSNBC News, USA
- CTV News, Canada
- CKCO-TV News, Canada
- CBC Ontario Morning, Canada
- The Discovery Channel
- WNYT, Albany, NY, USA
- WTEN-TV, Albany NY, USA
- CBC Metro Morning, Canada

- The Space Channel
- WCBS, New York, NY, USA
- Channel 4, Buffalo, NY, USA
- “Larry Silver Show” on Corus Radio Network
- “Peter Garland Morning Show” on AM980
- “The Jim Chapman Show” on CJBK
- “Derek Bottom Show” on The Hawk
- “Pete, Jeff & Mindy Show” on FM96

### PRINT MEDIA

- Page 3 article and photo in the “Globe and Mail” of X, Canada.
- Page 1 color photo and page 3 article in “National Post” of X, Canada
- The New York Observer
- The Ottawa Citizen, Ottawa, Ontario, Canada
- The London Free Press, London, Ontario, Canada
- Albany Times Union, Albany, NY, USA

## TEAM BACKGROUND

### TEAM MEMBERS

Other members of the Canadian Arrowteam include:

- Chris Corke, Design and Detail
- Dan McKibbon, Design and Design Presentation
- Paula Adams, Lawyer
- Matthew Bean, Director of Ground Operations
- John Chandler, Vehicle Design and Production
- Ed Das, Tool and Machining Design
- Larry Helwig, Flight Dynamics Engineer
- Ann Hutchison, Media Relations and Communications
- Ed Kambulow, Propellant Systems Design
- Tom MacDonald, Computer/Guidance Design
- Gregg Mackay, Structural Engineer
- Kim McKibbon, Materials Science
- Kirk Oliver, Chief Financial Officer
- Lori Sheerin, Office Administrator and Event Coordinator
- Cliff Simon, Concept Coordinator
- Dan Steinhaur, Propellant Systems Design
- Keith Thompson, Flight Medical Officer

### X PRIZE QUOTE

*"Although there are many different teams competing for the X PRIZE, we are all fundamentally on the same team. When one of us wins the X PRIZE, we will all become entrepreneurs and pioneers in the eyes of the world." – Geoff Sheerin*

### PHILOSOPHY

*“The Canadian Arrow team is a group of engineers, technicians, and support staff with no previous experience in the aerospace industry. Our approach to designing our space craft is to rely on previous engineering that is easily available and ready to use. All the engineering time and work is spent trying to reverse engineer and reapply previous designs available in the public domain. Our business strategy and brand development are uniquely our own.” – Geoff Sheerin*

### MISSION AND GOALS

*“We entered the competition to build and fly a manned suborbital vehicle. The X PRIZE makes it possible under the umbrella of a race to motivate and consolidate help from industry. We hope to make Canada into the space shuttle capital of the world.” – Geoff Sheerin*

## X PRIZE FOUNDATION

Below is contact information for the X PRIZE Foundation.

### MAILING ADDRESS

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Chesterfield, Missouri, USA 63005

### PHONE NUMBERS

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