# X PRIZE Team Summary Sheet
# TGV ROCKETS

All the information given in this document has been cleared for official release by the X PRIZE Foundation and the TGV team. Quotes provided by TGV are shown in italics. For more information about TGV, please visit their web site at www.tgv-rockets.com.

## TEAM OVERVIEW

TGV Rockets, Inc. is a dynamic team which is approaching the problem of winning the X PRIZE by looking beyond it. The $10 million will only be a stepping stone on the path toward providing suborbital flights on demand with minimal operational and material support requirements. TGV is aiming to revolutionize satellite photography using their vehicle.

### TEAM LEADER BACKGROUND

Kent Ewing comes to TGV from Leitch Incorporated, which he joined in 1993 as Director of Government Programs. He served as President from February 1996 to May 1998. Before starting at Leitch, Kent was Commanding Officer of the USS America (CV-66) during Desert Storm. In his Naval Career he also commanded USS Sylvania (AFS-2), Carrier Air Wing Seventeen, and Attack Squadron Sixty Six. He has flown 7500 hours in over 100 different military and commercial aircraft, and made over 1150 carrier landings. Kent holds a Bachelor of Science degree in Economics from the University of California at Los Angeles and a Masters of Science in Systems Management from the University of Southern California. A Dayton, Ohio native, Kent also is a 1974 graduate of the U.S. Navy Test Pilot School, Patuxent River, Class 65. In 1986 he was selected as a Senior Executive Fellow to the Harvard JFK School of Government.

## DATA AT-A-GLANCE

### TEAM SPECIFICATIONS

- Name: TGV Rockets, Inc.
- Leader: Kent Ewing
- Place: Bethesda, Maryland, USA
- Registered with X PRIZE: 28 June 1999
- Web: www.tgv-rockets.com

### VEHICLE SPECIFICATIONS

- Name: Modular Incremental Compact High Energy Low-cost Launch Example, M.I.C.H.E.L.L.E. -B
- Length: 37.4 feet
- Diameter: 7.9 feet
- GTOW: 61,327 $lb_m$
- Dry Weight: 17,635 $lb_m$
- Crew Environment: Pressurized cabin with backup pressure suits.
- Payload Capacity: 2,200 $lb_m$
- No. of Engines: 6
- Propulsion System: Pressure Fed
- Fuel: Hydrocarbon
- Oxidizer: Liquid Oxygen
- Total Thrust: 18,000 $lb_f$
- Reaction Control System: To be determined

### MISSION SPECIFICATIONS

- Alt. at Ignition: Earth Surface
- Orientation at Ignition: Vertical
- Max. Accel. Force on Ascent: 4.5 g
- Alt. at Engine Cut-off: 45 km
- Time at Engine Cut-off: 80 sec
- Max. Speed: 1,100 m/sec
- Max. Altitude: 104 km
- Time in Weightless Conditions: 200 sec
- Reentry Method: Piloted aerobrake ballistic descent
- Accel. Forces on Descent: 4.6 g peak, 30 sec over 3 g
- Landing Method: Piloted aerodynamic decelerator with powered descent onto landing gear
- Total Duration: 550 sec
- Landing Distance from Take-off Location: 0 km
- Time Between Missions: Less than one day

# VEHICLE/LAUNCH SYSTEM DESCRIPTION

The M.I.C.H.E.L.L.E.-B vehicle features the following:

- Modular design.
- Redundant independent propulsion modules containing tanks, pressurization system, and engine.
- Crew compartment, flight deck, and payload bay isolated from propulsion modules.
- Deployable aerodynamic decelerator of flexible mesh.
- Stowable landing gear.

The complete avionic suite includes an inertial navigation system, radar, global positioning system, and a self-contained precision approach system. For normal operation, there is no need for external tracking, range safety, or ground based telemetry systems.

Operational ground support requirements are minimal, consistent with aircraft operations. A ground power cart, fuel and oxidizer supply, and payload support systems are all that are needed to support a launch.

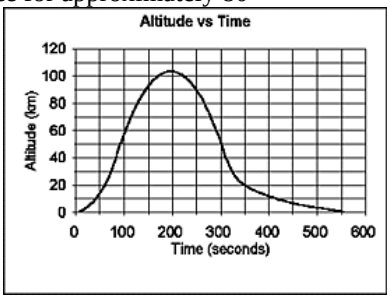
The payload bay can support a flexible payload configuration. Payload can be any combination of packages or passengers that fit within the payload bay and crew compartment envelope. A/C and D/C regulated power and a vehicle data bus are available. The payload bay is configured with a 19 inch and ISPR/Express rack capability, but special payload configurations can be accommodated by arrangement.

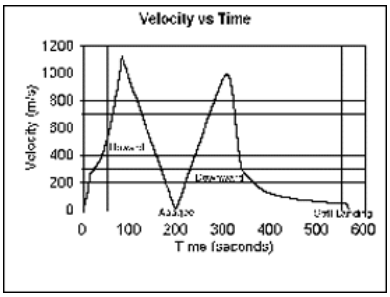
## PROPULSION SYSTEM

The propulsion system on the M.I.C.H.E.L.L.E.-B consists of six pressure fed, hydrocarbon/liquid oxygen engines delivering a total of 18,000 lbf of thrust at sea level. The engines burn for 80 seconds.

# MISSION DESCRIPTION

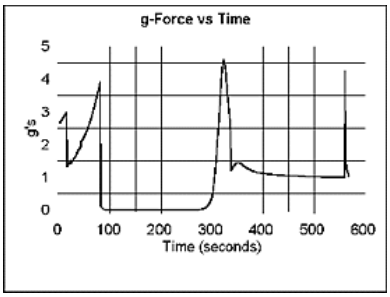
Powered ascent takes place for approximately 80 seconds, using varied power settings to manage dynamic pressure loads. Cruise to Maximum Altitude of 104 km, is followed by a gravity induced descent. A flexible aero-shield is deployed to reduce speed and moderate re-entry temperatures. At approximately 3 km, the shield begins retracting and landing power is applied. The pilot manages terminal maneuvers and manages all systems.




## VEHICLE ASCENT

We plan to use pilots to control the rocket. Pilots can react to and control the rocket in many situations that will be difficult to foresee. Pilots also eliminate the need for expensive control systems.




The simplest trajectory is a straight up, straight back path. This will allow the same crew and equipment to be used for both launch and recovery of the rocket.

## WEIGHTLESSNESS

After the engines cut off 80 seconds after lift-off, the M.I.C.H.E.L.L.E.-B vehicle ascends approximately 60 km to an apogee of 104 km and then begins a gravity-induced descent. At approximately 280 seconds after lift-off, a flexible aero-shield is deployed to reduce speed and moderate re-entry temperatures, ending the weightless portion of the flight.

During all this time, the crew and passengers experience microgravity conditions.

### VEHICLE DESCENT AND LANDING

Since the trajectory has minimal cross range travel, the only need for cross range velocity capability on decent is to correct for wind drift on return to the launch point. Since the time aloft will be short, most of the correction for wind drift can occur in the boost phase, and minimal correction should be needed on decent. This makes for an ideal situation for an aerodynamic drag recovery system. It is envisioned that at apogee the vehicle will deploy a large dive brake to increase the drag coefficient of the vehicle. The aero-brake will be sized to provide a low terminal velocity as the vehicle nears the recovery point. Preliminary estimates indicate that a dive brake capable of increasing the drag coefficient two orders of magnitude should be sufficient to provide a terminal velocity of under 50m/s for a 7000kg dry-weight vehicle.

## HARDWARE & TESTS

TGV Rockets currently has scale models of the M.I.C.H.E.L.L.E.-B.

There are no full-scale engineering mock-ups or prototypes of the M.I.C.H.E.L.L.E.-B.

## PUBLICITY

### PERSONAL APPEARANCES

TGV personnel have appeared at the EAA Oshkosh Air Show meetings of the Space Access Society and Space Frontier Foundation, Space Enterprise Symposium, STAIF, NRO and Space Transportation Association Conference.

### TELEVISION AND RADIO

- WMPT 22 Maryland
- The Space Show KFNX hosted by David Livingston

### PRINT MEDIA

- “Sub-orbital Rockets to Space: The next logical step?” by Clark S. Lindsey. Reprint of article accepted for March-April 2002 issue of Ad Astra Magazine - National Space Society.
- “Effective Ballistic Missile Defense Requires a New Testing Paradigm.” by Taylor Dinerman. SpaceEquity.com, 3/15/02
- "On Spaceplanes and X-Vehicles". Testimony by Henry F. Cooper to the House Subcommittee on Space and Aeronautics Committee on Science October 11, 2001.
- “It's only rocket science.” by Bill May. The Journal Record, 6/18/01
- “Venture capitalist says Oklahoma's on the right track.” by Bill May. The Journal Record Dolan Media 06/12/2001
- "Solar System for Sale? - Free marketeers want a piece of outer space". USNews.com 3/26/01, Science & Ideas
- "Rocket Men", by Larry Niven. Space.com, January 4, 2001.
- “Modular Technology for Space, or Why can't we build spaceships out of Lego blocks?” by Pat Bahn
- “The Suborbital Road to Space: One Small Step for Man, One Giant Leap for Mankind” by Pat Bahn, Karen Shea, and Eric Dahlstrom (as published in Space Front Magazine: The Journal of the Space Frontier Foundation)
- “Just a Couple of Sunday Drives...Into Space.” Speedvision.com, October 2000.
- “Entrepreneurs Cite Lessons, Progress Since Initial Presentations at Forum Holiday Party”, by Glenn Petherick, MIT Enterprise Forum newsletter
- MSNBC News: “Space ventures struggling in a dot-com world”
- Spaceviews.com: “New X Prize Competitors Announced”
- “The State and Fall of Small RLVs: A Report on the Space Access '99 Conference”
- “TGV Rockets Takes Off”
- “All Aboard for Space Tourists”
- “TGV Rockets Plans to Launch Reusable Sounding Vehicle.” Space News, January 17, 2000.
- “Cutting launch costs proves to be rocket science.” Potomac Tech Journal

## TEAM BACKGROUND

### TEAM MEMBERS

- Earl Renaud, Ph.D., Chief Operating Officer
- Pat Bahn, CEO

- Len Cormier, Chief Engineer
- Yuri Prihodko
- Robert Gradle

## X PRIZE QUOTE

*"Most of the great aviation achievements of the 20th century were driven by prizes. The feats of the Wright Brothers, Charles Lindbergh & Paul MacReady were all inspired by prize competitions. The X PRIZE is the first great prize of the 21st Century." – Kent Ewing*

## PHILOSOPHY

*"TGV Rockets philosophy can be found right in our name "Two Guys and a Van", which means that our goal is to operate vehicles which require that level of operating cost. TGV Rockets is pioneering the development and deployment of a unique, piloted reusable sub-orbital rocket, which will bring a cost-effective product to the emerging rocket industry. This rocket will form the core of a launch services business. Our key competitive advantage is the inherent simplicity of a sub-orbital rocket compared to an orbital application, in both development and operation. The technology to develop a sub-orbital product is largely available off-the-shelf as a result of prior rocket research, thereby greatly reducing development costs and project risk. This will enable the Company to focus on selling cheap reliable transportation, rather than developing state-of-the-art technology." – Pat Bahn*

## MISSION AND GOALS

*"At TGV we know that our strength lies in our people. We have built a world-class management team committed to technical and financial success, and the realization of our vision. Together we will change the space launch market and bring affordable access to space to the sub-orbital launch market." – Earl Renaud*

# X PRIZE FOUNDATION

Below is contact information for the X PRIZE Foundation.

## MAILING ADDRESS

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