J-2 (GX)

Outlook

- IHI liquidated the joint venture formed to develop, manufacture, and market the GX launch vehicle
- Japan cancelled funding for the GX launch vehicle, spelling the end of the program
- Liquefied natural gas-powered engine will continue development despite cancellation of GX program

Orientation

Description. The J-2 (GX) was to be a small-to-medium expendable launch vehicle.

Sponsor. The Galaxy Express consortium was developing the J-2, while Lockheed Martin Corp was expected to handle marketing and provide the Atlas III first stage for the GX. Lockheed Martin was also one of the shareholders in Galaxy Express.

Status. Japan canceled funding for the development of the J-2 (GX) in December 2009.

Total Produced. None

Application. The J-2 (GX) was being designed to deliver a 4,400-kilogram payload into LEO or a 2,000-kilogram payload to SSO.

Price Range. The most recent estimates place the cost of a single J-2 launch at 8 billion yen ($87 million). Total development costs would have exceeded 94 billion yen ($1 billion).

Contractors

Prime

IHI Corporation	http://www.ihi.co.jp, Toyosu IHI Building., 1-1, Toyosu 3-chome, Koto-ku, Tokyo, 135-8710 Japan, Tel: + 81 3 6204 7800, Fax: + 81 3 6204 8800, Prime (ATDR Team Leader; Second Stage Rocket Motor)

Subcontractor

Lockheed Martin Corp	http://www.lockheedmartin.com, 6801 Rockledge Dr, Bethesda, MD 20817 United States, Tel: + 1 (301) 897-6000, Fax: + 1 (301) 897-6704 (G-X Fuel Tank and Atlas III First Stage for G-X)
Mitsubishi Heavy Industries Ltd (MHI)	http://www.mhi.co.jp/en/, 16-5 Konan 2-chome, Minato-ku, Tokyo, 108-8215 Japan, Tel: + 81 3 6716 3111, Fax: + 81 3 6716 5800 (M3S2 Solid Rocket Motor Case)

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NPO Energomash JSC	http://www.energomash.ru/english, 1, Burdenko St, Khimki, 141400 Russian Federation, Tel: + 7 095 572 2200, Fax: + 7 095 251 7504, Email: energo@on-line.ru (RD-180 Engine)

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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

Design Features. Please note that while NASDA and the ISAS are now a part of JAXA, they have been referenced in this report using their previous acronyms for historical purposes.

J-1, Predecessor to the GX. In developing the J-1, NASDA and ISAS adopted the all solid-fueled features of the latter agency's stable of science rockets. The vehicle combined the mission-proven parts of the ISAS M-3SII rocket with those of the H-2 heavy-lift vehicle developed by NASDA.

The first stage of the J-1 was a three-stage launch vehicle, consisting of one H-2 solid rocket motor (SRM). The solid propellant used in the SRM was 14 percent hydroxyl terminated polybutadiene (HTPB), 18 percent water/methanol, and 68 percent ammonium perchlorate. On the H-2, the booster held about 59,000 kilograms of propellant, packed into a four-segment rocket casing.

Four tailfins were located at the base of the J-1's first stage. Two small external fuel tanks supplied propellant to a pair of vernier rockets located opposite each other just above two of the fins.

The second stage consisted of the solid-propellant upper stage borrowed from the M-3IIS rocket. On the M-3IIS, the stage contained 10,300 kilograms of solid 7-star grain HTPB composite propellant in a maraging steel case. Average thrust of the stage was 526 kN for 50 seconds.

The second stage also featured a liquid injection thrust vector control (LITVC) around the nozzle to control the thrust direction. The LITVC produced horizontal thrust by blowing liquid sodium perchlorate, contained in a small storage tank, through injecting pipes into the gas chamber. Eight injecting pipes inside the nozzle each had a valve that controlled the pitch/yaw direction of the second-stage motor during burn by opening or closing according to signals from the control electronics.

J-2/GX. Reports began circulating in 1998 of efforts by the J-1 contractors to develop what was then described as a J-1 upgrade. This booster would cost much less than its predecessor, of course, and would also have a greater payload capability to LEO. At various times called the J-1A, J-2, J-U, ATDR, and now the GX, this follow-on is similar to its predecessor, but has only two stages. Unlike the J-1, the GX would have been powered by liquid fuel rocket engines, using components supplied by overseas manufacturers.

Lockheed Martin was going to supply the lightweight fuel tank from the Atlas III rocket, which uses liquid oxygen and kerosene and the Atlas III first stage. The GX's main engine would have been an NPO Energomash/Pratt & Whitney RD-180 liquid oxygen and kerosene booster. Designed in the 1990s, the RD-180 has been used by the U.S. Atlas IIIA, IIIB, and Atlas V.

IHI and JAXA began developing an all-new rocket engine for the second stage, employing a simple pressure-fed system. This powerplant will burn liquid oxygen and liquefied natural gas, the first such use for the chemical. Japan is expected to continue work on the engine, even though the J-2 (GX) program was cancelled.

The new vehicle would have been capable of placing 4,400 kilograms in low-Earth orbit, according to documents dated 2005. The target cost was about $24 million per launch.

(GX)	Metric	U.S.
Dimensions		
Length	48 m	157.4 ft
First stage diameter	3.1 m	10.2 ft
First stage length	30.6 m	100.4 ft
Second stage diameter	3.1 m	10.2 ft
Second stage length	7.8 m	25.6 ft

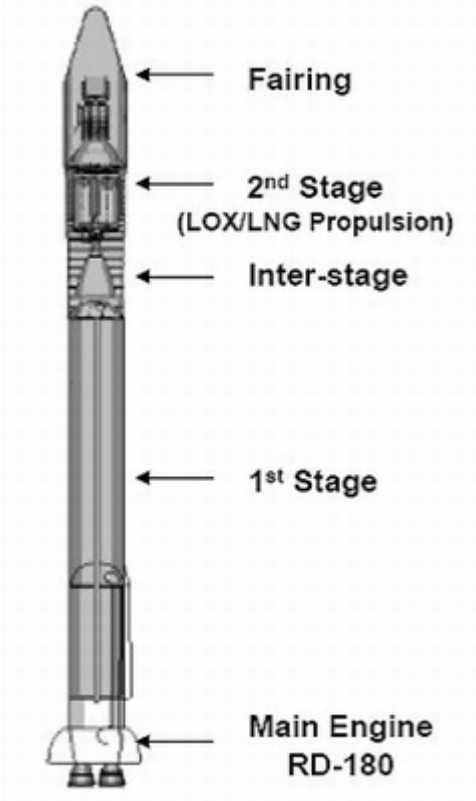
J-2 (GX)

(GX)	Metric	U.S.
Fairing diameter	3.3 m	10.8 ft
Fairing length	9.6 m	31.5 ft
Weights (Fueled)		
Overall weight	210,000 kg	462,000 lb
First stage	197,000 kg	433,400 lb
Second stage	15,000 kg	33,000 lb
Fairing	1,000 kg	2,200 lb
Performance		
Payload to LEO (200 km)	4,400 kg	9,680 lb
Payload to SSO (800 km)	2,000 kg	4,400 lb

Propulsion

Stage 1 (1) NPO Energomash/P&W RD-180 liquid propulsion (liquid oxygen and kerosene) rocket engine, 3,825 kN (860,000, lbst) (sea level).

Stage 2 (1) Liquefied natural gas rocket engine, 98 kN (22,045 lbst).



The Galaxy Express J-2 (GX)

Source: Galaxy Express

Variants/Upgrades

J-1. Two-stage, solid-propellant, expendable launch vehicle. Launched once; second launch was shelved.

J-2 (GX)

Program Review

Background. The development of the J-2/GX actually begins with its predecessor, the J-1. In 1996, Japan carried out the J-1's first flight and launched a hyperonic flight experiment, called Hyflex, to an altitude of 110 kilometers. Unfortunately, after splashing down in the Pacific Ocean off the east coast of Japan, the Hyflex vehicle separated from its floatation bag and sank in waters 6,000 meters deep. Designed to collect data on thermal protection and aerodynamic heating in hypersonic flight, Hyflex was a precursor to the H-2 Orbiting Space Plane-X (HOPE-X).

Japan had hoped the J-1 would be a relatively inexpensive launch vehicle, but the first mission cost more than $45 million. For the price of a J-1, a customer could buy a Boeing Delta II rocket with nearly four times the payload capacity to LEO. Efforts to dramatically cut the cost of the follow-on J-1 were only partly successful, with about $6 million shaved off.

Faced with the prospect of producing a rocket that the Japanese government could not afford, the J-1's manufacturers offered a different design in 1998, one borrowing components from overseas suppliers. The booster's first stage, for example, would be powered by a Russian rocket engine, the RD-180, which is used the world over. In addition, the second stage would use a unique and technologically unsophisticated engine that burns liquefied natural gas.

In April 2000, Nissan Motor Co Ltd was sold to Ishikawajima-Harima Heavy Industries (IHI) for approximately $380 million, making IHI the third largest defense vendor in Japan. Originally, NEC was to serve as a subcontractor in the program, providing the vehicle's second stage; however, IHI took over the role of NEC in the development of the GX.

A year later, in May 2001, a group of Japanese companies formed Galaxy Express, a joint venture to develop the J-2 with help from the Japanese government. Partners included Ishikawajima-Harima Heavy Industries, Mitsubishi Heavy Industries Corp, Kawasaki Heavy Industries Ltd, IHI Aerospace Corp, Japan Aviation Electronics Industry Ltd, Fuji Heavy Industries Ltd, and Kokusai Sohko Co. Lockheed Martin Corporation of Bethesda, Maryland, will supply critical propulsion components and is also responsible for marketing the GX.

Galaxy Express planned to initially launch the GX from Tanegashima Island, some 1,000 kilometers southwest of Tokyo, the National Space Development Agency's launch pad. Plans called for future launches to take place from Christmas Island in Kiribati, some 2,000 kilometers south of Hawaii.

Final J-1 Launch Shelved. Late in 2001, Japan put the development of the second J-1 on hold while it reassessed space program funding and launch schedules. To date, the rocket is still presumably in storage. The OICETS payload it was to carry was flown on a Russian Dnepr in August 2005.

GX Development Status. In Japanese fiscal year (JFY) 2003, a test was conducted in normal temperature and cryogenic conditions on a full-scale model of the liquid natural gas (LNG) composite cryogenic tank. The objective of the test was to obtain data relative to structure, including distortion and displacement data. According to Galaxy Express, the objective was "mostly fulfilled as planned." A full-scale model of a liquid oxygen (LOX) composite cryogenic tank was manufactured as well.

The second major test in JFY03 was a battleship firing test (BFT) conducted on the LNG propulsion system. This test uses a stronger composite structure than that of the flight model, and is called a BFT because the reinforced tank used is reminiscent of the plating found on a battleship. The test was successful and included a firing of 353 seconds, which is the estimated mission duty cycle required for flight operations.

GX Program Cancelled

In December 2009, the Japanese government decided to cancel funding for the GX program. Tokyo determined that the development of the launch vehicle was consuming funds that could better be used on other programs. The launch vehicle has suffered from a number of delays and cost increases. The cost of a single launch is now estimated to be about $87 million, putting the launch vehicle at a severe price disadvantage in the commercial launch market. A month later, IHI announced plans to liquidate the joint venture formed to develop and market the GX. Without government funding, the initiative would not be profitable.

Timetable

Month	Year	Major Development
Mid-	1991	NASDA announces start of J-1 R&D program
Feb	1996	Hyflex launched on J-1, first mission
Dec	2009	Japan announced decision to cut GX funding
Jan	2010	IHI announced plans to liquidate joint venture formed to develop and market GX launch vehicle

Forecast Rationale

In December 2009, the Japanese government announced that it was canceling funding for the GX program. The program to develop the launch vehicle suffered from delays and cost increases. Threats to cancel the program have been around for a while, especially since a committee overseeing Japan's space development activities issued a condemning report in 2006. One committee member even suggested that technology being developed for the GX would be obsolete by the time the launch vehicle entered service.

The primary issue that forced the cancellation of the GX was cost increases. The cost to develop the GX has already reached about $750 million, and by some estimates could cost an additional $1 billion if continued. In addition, the cost of launching a single rocket is now estimated to be around $87 million. This is significantly higher than the $24 million engineers were initially aiming for. The GX would just not be competitive in the international launch market at that price. Under those circumstances, the GX would depend solely on the Japanese government for contracts.

Without the support of the Japanese government, IHI Corp announced plans in January 2010 to liquidate the joint venture formed to develop, manufacture, and market the GX. With no commercial or government support, the GX program has ended. While the government plans to continue development of the liquefied natural gas engine, there does not seem to be much of a market for a GX-type launcher from Japan. This report will be archived next year, barring any unforeseen developments that change the outcome.

Ten-Year Outlook

No production forecast during the next 10 years. This report will be archived next year.

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