ARCHIVED REPORT

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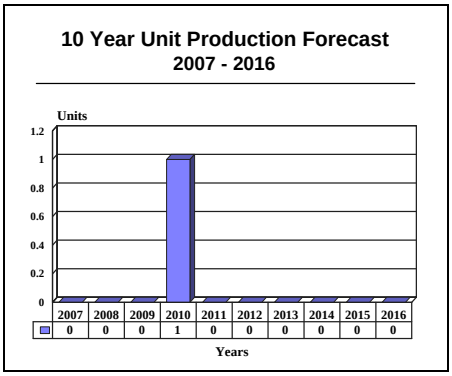
Lunar-A - Archived 3/2008

Outlook

- Launch before 2010 unlikely
- Penetrator portion of the mission is the primary focus
- Lunar-A penetrator could be used on a different JAXA mission if Lunar-A program is deemed too risky
- JAXA budget cuts will make redesigns problematic



Orientation

Description. Lunar-A is a spacecraft designed to orbit the Moon. Included on the spacecraft are two probes that will penetrate the lunar surface.

Sponsor. The Japanese Institute of Space and Astronautical Science (ISAS, now part of JAXA) and the Japanese Ministry of Education are the sponsors of the mission.

Status. Currently under evaluation, Lunar-A was slated for launch aboard a Japanese M-5 rocket, but this has not taken place and no date has been set.

Total Produced. None

Application. Lunar-A will study the Moon's interior structure and core using seismometers. Heat flow probes will measure the near-surface thermal properties and heat flux. The spacecraft is also equipped with a camera that will take topographical images of the Moon.

Price Range. Lunar-A was originally to cost approximately $150 million to design and build; however, numerous program delays could tack another $70 million onto the total price.

Contractors

Prime

NEC Toshiba Space Systems Ltd	http://www.ntspace.jp, 1-10, Nissin-town Fuchu-city, Kohoku-ku, Tokyo, 183-8551 Japan, Tel: + 81 042 354 4000, Email: Webinfo@ntspace.jp, Prime

Subcontractor

IHI Aerospace Co Ltd	http://www.ihi.co.jp/ia/, Shin-Ohtemachi Bldg., 2-1,, Ohtemachi 2-chome, Chiyoda-ku,, Tokyo, 100-8182 Japan, Tel: + 81 3 3244 5913, Fax: + 81 3 3244 5918 (Penetrator Separation System; Penetrators)

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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

Lunar-A

Artist's Impression of Lunar-A with Penetrator (below spacecraft)

Source: JAXA

Technical Data

Design Features. Lunar-A is a spin-stabilized spacecraft controlled by an N_2H_4 monopropellant reaction control system. Orbital maneuvering near the Moon will be done using a bipropellant (N_2O_4 and N_2H_4) engine. The main structure of the spacecraft is a 120-centimeter-diameter cylinder, which is 111 centimeters in height, excluding the engine nozzle, which protrudes from the bottom of the craft. An orbit maneuvering system, S-band antenna, and UHF-band antenna are situated on an end of the cylinder, and a reaction control and another S-band antenna on the other end. Three solar arrays extend perpendicular to the cylinder axis, equally spaced around the body.

A monochromatic camera with a resolution of 30 meters is attached to the side of the cylinder below one of the solar panels. It will be used to take images near the terminator (the dividing line between the light and shaded regions), where the lighting will enhance subtle topographic features.

After Lunar-A is launched, it will be put into a parking orbit around the Earth. The next step is to inject the spacecraft into an orbit around the Earth and Moon and after four and a half of these orbits are performed, the Lunar-A will move into a wide orbit with an apogee of 1,185,000 kilometers. At the end of this orbit, the Lunar-A will re-encounter the Moon and enter a 30° lunar orbit.

The spacecraft will deploy two 13-kilogram penetrators (see diagram below) over the course of a month. The penetrators are 90 centimeters in length and 14 centimeters in diameter, and are attached to the sides of the orbiter body between the solar arrays. They will be individually released and impact the Moon, burrowing 1 to 3 meters into the surface.

One penetrator will be targeted at the equatorial area of the near side and one at the equatorial far side. Each penetrometer contains a two-component seismometer, a heat flow probe, a tiltmeter, an accelerometer, a radio transmitter, and an antenna. The instruments are powered by Li-$SOCL_2$ (super lithium) batteries with an expected lifetime of one year. The penetrators are designed to withstand an impact force of 10,000 G.

After deploying the penetrators, the orbiter will move up to a 200- to 300-kilometer near-circular-mapping orbit. Data will be stored in memory in the penetrators and transmitted to the orbiter when it transits over each penetrator every 15 days.

	Metric	U.S.
Dimensions		
Diameter	1.2 m	3.9 ft
Height	1.1 m	3.6 ft
Weight		
On-orbit dry mass	520 kg	1,146.6 lb
Performance		
Altitude (from lunar surface)	200 km	124.2 mi
Spatial resolution	30 m	98.4 ft
Solar panels	4	4

Program Review

Background. The Lunar-A program is Japan's first lunar probe. The program is being funded by Japan's Ministry of Education through JAXA. Due to the complexity of the assignment, the mission had to be redesigned after several instruments failed vibration and drop tests. Additionally, the penetrators were unable to disengage properly from the Lunar-A platform.

As a result, the mission was postponed by 18 months, shifting the launch year from 1997 to 1999. Funding shortages and developmental problems with the lithium batteries have pushed the launch date even further back. When it does launch, the Lunar-A will do so on an M-5 launch vehicle from Kagoshima Space Center, Japan.

Space Agencies Merged. After concluding that activity within Japan's various space agencies often overlapped, in 2001 the Japanese government opted to merge the National Space Development Agency of Japan (NASDA), the Institute of Space and Astronautical Science (ISAS), and the National Aerospace Laboratory (NAL). The official English name of this group is the Japanese Aerospace Exploration Agency (JAXA). The change took effect in October 2003.

According to the decision proposed by the Ministry of Finance, the three organizations will collaborate on all projects through the establishment of a joint program office. This office will coordinate all efforts, including launch vehicle development, spacecraft development, and the sharing of ground facilities.

Funding

Funding for the Lunar-A program is provided by the Ministry of Education, Japan.

Timetable

Month	Year	Major Development
August	2004	Previously planned launch of Lunar-A aboard an M-5 rocket
	2010	Possible launch of Lunar-A aboard an M-5 rocket

Forecast Rationale

The Lunar-A mission has been suspended since 2004 mainly because of a recall and replacement of thruster bulbs of the spacecraft. The less than perfect penetrator qualification test (QT) performed in November 2003 didn't help either as it resulted in a sequence skip of the program that was also one of the main reasons for the suspension of the mission development at that time. Since then, the Lunar-A project had been reviewed in all aspects, including technical feasibility and management strategy. From the recommendation by the review boards in 2004, JAXA made a decision to concentrate on the development of the penetrator technologies prior to the development of the spacecraft.

Lunar-A

In the development of the penetrator, two major points must be considered. First and foremost is assuring the robustness of the communication link between the penetrator and spacecraft to ensure positive data acquisition during the deployment phase. Second is the addition of a CPU reset circuit for possible malfunction, which reportedly occurred during one of the experiments. In order to clear these problems, some modifications of electronics circuits were required; additionally, the development of a new sensor was also required. In FY05, JAXA estimated that it would take about three years to accomplish these goals. A communication test with the penetrator was done in Mexico in June 2006, which was reportedly successful.

Although the launch date was changed many times in the past for various reasons, the essential mission concept has been kept. The launch of Lunar-A looks pretty shaky right now and we could see the program cannibalized for a future penetrator mission. The relatively strong ground that Selene – Japan's other lunar mission – is on could facilitate a redirection for Lunar-A.

The Japanese Parliament has cut the budget of the country's space agency – JAXA – every year since it was created in 2003. Prior to the creation of JAXA, the budgets of the three institutions that now make up the space agency were also cut, on a seemingly annual basis.

JAXA is currently operating on a budget of approximately $2 billion or about one-tenth of the NASA budget. JAXA has reportedly asked for a funding increase but the prospects aren't that great as the country's economy is still on the rebound from a decade-plus of underwhelming growth.

Forecast International expects that national pride may indeed provide the impetus for a small boost in the budget thanks to the increasing space activities of regional neighbor China. China conducted two successful manned spaceflights within 24 months, the most recent of which included two Chinese astronauts in October 2005. While JAXA is in no hurry to get itself in the middle of a space race, it also doesn't want to be left too far behind.

JAXA has a major hurdle to clear if it wants to launch Lunar-A, or any other spacecraft for that matter. The Lunar-A mission has cost $209 million so far, and at least another $20 million will be needed to complete the spacecraft.

As it stands now, Forecast International is still issuing a forecast for Lunar-A; however, given the notoriously tight budget environment that JAXA operates under, this could change rather quickly. An official and final decision regarding Lunar-A will probably come from JAXA this year.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

		High Confidence Level			Good Confidence Level				Speculative			
Space System	**thru 06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**Total 07-16**
JAXA												
LUNAR-A	0	0	0	0	1	0	0	0	0	0	0	1
Total Production	0	0	0	0	1	0	0	0	0	0	0	1