23 August
NATIONAL SPACE DAY
Touching lives while touching the Moon: India's Space Saga

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LAUNCH VEHICLES

Space Transportation System of ISRO

"An ability to question basic assumptions in any situation is fostered by probing the frontiers of science."

Dr Vikram Ambalal Sarabhai

The Converge

In the early 1960s, the Indian National Committee on Space Research (INCOSPAR), the Indian counterpart of the Committee for Space Research (COSPAR) of the United Nations, was formed under the leadership of Dr Vikram A Sarabhai. INCOSPAR pioneered studies on the phenomenon of Electrojet Streams which is a narrow belt of electrons moving from West to East above the Magnetic Equator. The height at which this current flows, is beyond the reach of instrumented balloons and too low for satellites. The best way to study the phenomenon is to launch Sounding Rockets into this region to make measurements.

Thumba Equatorial Rocket Launch Station (TERLS) in Thiruvananthapuram, Kerala was established in 1962. A Sounding Rocket Nike-Apache was successfully launched from TERLS on 21st November, 1963 and was vital in gathering more information about the Electrojet Streams above the Magnetic Equator.

St Magdalene Church in Thumba, Thiruvananthapuram played a crucial role in serving as the first office and laboratories to launch the first Sounding Rockets into space as the pioneering feat towards Space Science and Technology in the coming years. It was a start of the era that dreamed, hoped and achieved.

As Dr Vikram Sarabhai once said, “There is no leader and led. A leader, if one chooses to identify one, has to be a cultivator rather than a manufacturer. He has to provide the soil and the overall climate and environment in which the seed can grow”. Yes, the seeds sown by him in Thumba have grown today into ISRO, India is so proud.

Sounding Rockets

Sounding Rockets are one or two-stage solid propellant rockets used for probing the upper atmospheric regions and for space research. The first rockets were two-stage rockets imported from Russia (M-100) and France (Centaure). While the M-100 could carry a payload of 70 kg to an altitude of 85 km, the Centaure was capable of reaching 150 km with a payload of approximately 30 kg. In 1975, all sounding rocket activities were consolidated under the Rohini Sounding Rocket (RSR) Programme, which was the first truly Indian Sounding Rocket. Currently, three versions (RH-200, RH-300 Mk II, RH-560 MK II) are offered as operational Sounding Rockets, which cover a payload range of 8-100 Kg and an apogee range of 80-475 km.

Rocket Artist

After the successful launch of the Sounding Rockets, there was a quantum rise in the field for research in aeronomy and atmospheric science in India. Dr Vikram Sarabhai inspired many young scientists and also dreamed of India being second to none. From TERLS (Thumba Equatorial Rocket Launch Station) to VSSC (Vikram Sarabhai Space Centre) the journey of launch vehicles is fast and furious.

The Launch Gallery

The Sounding Rocket Programme was the solid foundation on which the development of Launch Vehicle Technology was sophisticated by ISRO.

What do Launch Vehicles do?

Well, the purpose of Launch Vehicles is to carry satellites or spacecraft and place them at great heights in the required orbits. It started with simple Satellite Launch Vehicle (SLV-3) and enhanced into advanced major Launch Vehicles. ISRO rapidly achieved in developing launch vehicle technology and continues to research, builds and launches satellites for various applications.

Satellite Launch Vehicle-3 (SLV-3)

SLV-3 was India’s first experimental satellite launch vehicle. It launched successfully Rohini Satellite that was carrying a Landmark Camera System into a Near-Earth Orbit. India became the 6th country of an exclusive club of spacefaring nations with the successful launch of SLV-3 on July 18, 1980, from Sriharikota Range (SHAR).

SLV-3 became the base structure for more major Launch Vehicles built after its successful launch by ISRO: ASLV, PSLV, GSLV and LVM 3.

Augmented Satellite Launch Vehicle (ASLV)

After being built on the experience gained from SLV-3, ASLV proved to be a low-cost intermediate vehicle demonstrating the technical worth of ISRO in its strap-on technology and more.

Polar Satellite Launch Vehicle (PSLV)

PSLV is the third generation Indian Launch Vehicle and the first to be equipped with liquid stages. PSLV, the workhorse of ISRO, is capable of launching satellites into different types of orbits like Sun-synchronous Polar Orbit (SSPO), Low Earth Orbit (LEO) and Geosynchronous Transfer Orbit (GTO) and even deep space missions. PSLV has completed 48 missions and placed satellites in different orbits, which include India's remote sensing and Communication Satellites, maiden lunar mission Chandrayaan-1, Mars Orbiter Mission (MOM) spacecraft, maiden sun mission Aditya-L1, XPoSat, Indian Regional Navigational Satellite Constellation (NavIC), besides many foreign satellites. Another notable feature was the launch of PSLV-C37 on 15 February 2017 successfully deploying 104 satellites in a Sun-synchronous orbit. PSLV demonstrated critical technologies like PS2 engine restart, injecting satellites into multiple orbits in the same mission and India's unique inexpensive space platform using the spent PS4 Stage called POEM for micro gravity experiment.

Geosynchronous Satellite Launch Vehicle (GSLV)

GSLV is the largest fourth-generation Indian launch vehicle. It is a three stage vehicle with four Liquid Strap-ons, a Solid Rocket Motor and also has a Cryo Upper Stage. Initially, the vehicle flown with Russian cryo stages and later with cryogenic stage developed by ISRO. GSLV is designed to launch a 2.0 ton class of satellites into Geosynchronous Transfer Orbit (GTO). GSLV's primary payloads are INSAT class of communication satellites that operate from Geostationary Orbits. GSLV completed 12 successful launches.

LVM 3

LVM 3 is a three-stage heavy-lift Launch Vehicle completely indigenised and developed by ISRO. The Launch Vehicle has two solid Strap-ons, a Core Liquid Booster and a Cryogenic Upper Stage. LVM 3 is designed to carry 4 ton class of satellites into Geosynchronous Transfer Orbit (GTO) or about 10 tons to Low Earth Orbit (LEO), which is about twice the capability of GSLV.

The first developmental flight of LVM 3, the GSLV Mk-III D1 (LVM 3) successfully placed GSAT-19 satellite to a Geosynchronous Transfer Orbit (GTO) on June 05, 2017 from SDSC SHAR, Sriharikota. LVM3 completed 7 successful launches, which includes 2 commercial missions & Chandrayaan 2 & 3 Missions.

Small Satellite Launch Vehicle (SSLV)

SSLV is the new launch vehicle of ISRO capable of launching Mini, Micro or Nano satellites (10 to 500 kg mass) to 500 km planar orbit. SSLV is a three-stage vehicle with all solid propulsion stages. SSLV completed two successful launches and EOI released for transfer of technology to NGPEs.

Human Rated Launch Vehicle (HRLV)

The Launch Vehicle is man-rated version of LVM 3 which is expected to take two-three crew to 300-400 km orbit.

Reusable Launch Vehicle – Technology Demonstrator (RLV-TD)

Reusable Launch Vehicle – Technology Demonstrator (RLV-TD) is one of the most technologically challenging endeavours of ISRO towards developing essential technologies for a fully Reusable Launch Vehicle to enable low-cost access to space.

RLV-TD is the first unmanned flying testbed developed for ISRO's Reusable Launch Vehicle Technology Demonstration Programme. It is scaled up to become the first stage of India's Reusable Two Stage Orbital Launch Vehicle. The winged RLV-TD has to evaluate various technologies—Hypersonic Flight, Autonomous Landing and Powered Cruise Flight.

On May 23, 2016, RLV-TD was successfully flight tested from Satish Dhawan Space Centre, SHAR, Sriharikota.

Objectives of RLV-TD:

- Hypersonic Aerothermodynamic Characterisation of wing body
- Evaluation of autonomous Navigation, Guidance and Control (NGC) schemes
- Integrated Flight Management
- Thermal Protection System Evaluation and Re-entry Mission Management

RLV- Landing Experiment (RLV-LEX)

Reusable Launch Vehicle (RLV) Landing Experiment (LEX) is successfully demonstrated the autonomous landing capability of the RLV in three experiments under various challenging release conditions. The winged vehicle, named 'Pushpak', was released from an Indian Air Force Chinook Helicopter at an altitude of 4.5 km. From a release point 4.5 km away from the runway, Pushpak autonomously executed cross-range correction manoeuvres, approached the runway and performed a precise horizontal landing at the runway centreline. Due to this vehicle's low lift-to-drag ratio aerodynamic configuration, the landing velocity exceeded 320 kmph, compared to 260 kmph for a commercial aircraft and 280 kmph for a typical fighter aircraft. After touchdown, the vehicle velocity was reduced to nearly 100 kmph using its brake parachute, after which the landing gear brakes were employed for deceleration and stop on the runway. During this ground roll phase, Pushpak utilises its rudder and nose wheel steering system to autonomously maintain a stable and precise ground roll along the runway. This mission simulated the approach and landing interface and high-speed landing conditions for a vehicle returning from space, reaffirming ISRO's expertise in acquiring the most critical technologies required for the development of a Reusable Launch Vehicle (RLV).

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