



ISRO to Launch LVM3 with Semi-Cryogenic Stage

[Source: TH](#)

Why in News?

The [Indian Space Research Organisation \(ISRO\)](#) has set the target for the first quarter of **2027** for the inaugural flight of its **LVM3 launch vehicle** equipped with a [semi-cryogenic propulsion stage](#).

What are the Cryogenic and Semi-Cryogenic Engines?

- **Cryogenic Engine/Cryogenic Stage:** A cryogenic stage uses **Liquid Oxygen (LOX)** and **Liquid Hydrogen (LH2)** as propellants, liquefied at **-183°C** and **-253°C**, respectively.
 - It is used in the **upper stage** of launch vehicles like **GSLV**, offering **high efficiency and thrust**.
 - **Cryogenics** is also used in **MRI machines** (using **liquid helium** for cooling), **food storage and preservation**, **special effects** (artificial fog), **recycling** (material separation), **biomedical preservation** (freezing **blood and tissue samples**), and in **cooling superconductors** for scientific and industrial use.
 - India developed its own cryogenic technology with the **first engine test in 2003** and **first successful flight in 2014** (GSLV-D5/GSAT-14).
- **Semi-Cryogenic Engine:** A [Semi-Cryogenic Propulsion Engine/Stage](#) uses a combination of [liquid oxygen \(LOX\)](#) and refined hydrocarbon fuel (e.g., kerosene) as propellants.
 - It is designed to power the **booster stages of future heavy-lift launch vehicles** and offers **higher density impulse** than cryogenic systems, enhancing overall propulsion performance. It will support upcoming platforms like the [Next Generation Launch Vehicle \(NGLV\)](#).

Cryogenic vs Semi-Cryogenic Engines: Key Differences

Feature	Cryogenic Engine	Semi-Cryogenic Engine
Fuel	Liquid Hydrogen (LH ₂) + Liquid Oxygen (LOX)	Refined Kerosene (RP-1) + Liquid Oxygen (LOX)
Fuel Temperature	LH ₂ at -253°C, LOX -183°C	-183°C, Kerosene stored at ambient temperature
Complexity	High (due to handling ultra-cold LH ₂ , insulation challenges)	Lower (kerosene is stable at room temperature)
Cost	Expensive (LH ₂ production/storage costs, complex infrast-)	Cheaper (kerosene is cost-effective, simpler logistics)
Thrust	Lower thrust but higher specific impulse (efficiency in vacuum)	Higher thrust (ideal for heavy-lift boosters)
Advantages	<ul style="list-style-type: none">- High efficiency (specific impulse -450 sec)- Clean exhaust (water vapor)	<ul style="list-style-type: none">- Higher thrust-to-weight ratio- Higher density impulse (more fuel storage)- Cost-effective

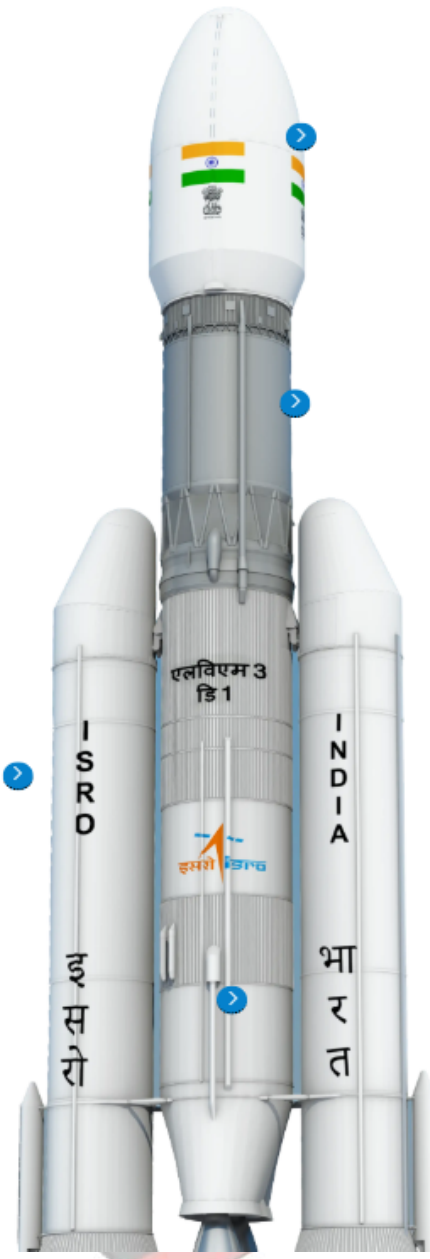
What is the LVM3 Launch Vehicle?

- **About:** LVM3 is **ISRO's most powerful, heavy-lift, 3-stage launch vehicle**, formerly known as the **Geosynchronous Satellite Launch Vehicle Mk III (GSLV Mk III)**.
 - It had its **first experimental flight in December 2014** and is capable of **launching payloads up to 4000 kg to Geosynchronous Transfer Orbit (GTO)**.
- **3 Stages:**
 - **First Stage:** Two **S200 solid strap-on boosters** attached to the sides of the core, using **hydroxyl-terminated polybutadiene (HTPB)** as the solid propellant.
 - **Second Stage (Core Stage):** The **L110 liquid stage** powered by **twin Vikas engines**, which burn a combination of **unsymmetrical dimethylhydrazine (UDMH)** and **nitrogen tetroxide (N₂O₄)**.
 - **Third Stage (Upper Stage):** The **C25 cryogenic stage** powered by the **CE20 engine**, using **liquid hydrogen (LH₂)** and **liquid oxygen (LOX)** as propellants.
- **Key Upgrades in LVM3 Launch Vehicle:**
 - **The LVM3 upgrade** replaces the L110 liquid stage with the **SC120 semi-cryogenic stage** powered by the **SE2000 engine** (200-tonne thrust), using **refined kerosene (RP-1) and LOX**.
 - It also increased the C25 cryogenic stage capacity to **32 tonnes**. This enhances **GTO**

payload capacity to around 5,200 kg, reduces launch costs by **around 25%**, and improves environmental safety.

- The upgrade boosts **India's heavy-lift capability** for future satellite missions and aligns with ISRO's next-gen launch plans.

LVM3(Geosynchronous Satellite Launch Vehicle Mk III)



Vehicle Specifications

Height	: 43.5 m
Vehicle Diameter	: 4.0 m
Heat Shield (Payload Fairing) Diameter	: 5.0 m
Number of Stages	: 3
Lift Off Mass	: 640 tonnes

Technical Specification

Payload to GTO: 4,000 kg
LVM3 will be capable of placing the 4 tonne class satellites of the GSAT series into Geosynchronous Transfer Orbits.

Payload to LEO (Low Earth Orbit) : 8,000 kg
The powerful cryogenic stage of LVM3 enables it to place heavy payloads into Low Earth Orbits of 600 km altitude.

Cryogenic Upper Stage : C25
The C25 is powered by CE-20, India's largest cryogenic engine, designed and developed by the Liquid Propulsion Systems Centre.

Cryo Stage Height	: 13.5 m
Cryo Stage Diameter	: 4.0 m
Engine	: CE-20
Fuel	: 28 tonnes of LOX + LH2

Solid Rocket Boosters : S200
LVM3 uses two S200 solid rocket boosters to provide the huge amount of thrust required for lift off. The S200 was developed at Vikram Sarabhai Space Centre.

Booster Height	: 25 m
Booster Diameter	: 3.2 m
Fuel	: 205 tonnes of HTPB (nominal)

Core Stage : L110 Liquid Stage
The L110 liquid stage is powered by two Vikas engines designed and developed at the Liquid Propulsion Systems Centre.

Stage Height	: 21 m
Stage Diameter	: 4 m
Engine	: 2 x Vikas
Fuel	: 115 tonnes of UDMH + H2O

What are the Key Missions Launched by ISRO's LVM3 Rocket?

Mission Name	Launched In	Payload / Objective	Remarks
LVM-3/CARE Mission	2014	Crew Module Atmospheric Re-entry Experiment (CARE)	Experimental suborbital flight, tested re-entry
LVM3-D1 / GSAT-19 Mission	2017	GSAT-19 communication satellite	First orbital test launch
LVM3-D2 / GSAT-29 Mission	2018	GSAT-29 Mission communication satellite	Demonstrated heavy communication satellite

			launch
LVM3-M1 / Chandrayaan-2	2019	Chandrayaan-2 lunar orbiter, lander, and rover	Chandrayaan-2 Mission
LVM3-M2 / OneWeb India-1	2022	36 OneWeb Gen-1 satellites (Low Earth Orbit, LEO)	OneWeb India-1 Mission
LVM3-M3 / OneWeb India-2	2023	36 OneWeb Gen-1 satellites (LEO)	OneWeb India-2 Mission
LVM3-M4 / Chandrayaan-3	2023	Chandrayaan-3 lunar lander and rover	India's 3rd lunar mission

ISRO LAUNCH VEHICLES

BACKGROUND

- First rocket developed by ISRO - **SLV** (Satellite Launch Vehicle)
- Successor of SLV - **Augmented Satellite Launch Vehicle** (ASLV)

Polar Satellite Launch Vehicle (PSLV)

- About**
 - The **Workhorse of ISRO**
 - 3rd gen, 4-Stage launch vehicle (1st, 3rd stages - solid fuel; 2nd, 4th stages - liquid fuel)
- Capacity**
 - Delivers **earth-observation/remote-sensing satellites**
 - Used to launch satellites of lower mass (~1400 Kg)
- 4 Variants:**
 - PSLV-CA PSLV-QL PSLV-DL PSLV-XL
- Launches Satellites in**
 - Low Inclination LEO Sub-GTO GTO
- Important Launches**
 - First successful launch - October 1994
 - Chandrayaan-1 (2008)
 - Mars Orbiter Spacecraft (2013)

PSLV is 1st Indian launch vehicle to be equipped with liquid stages



Geosynchronous Satellite Launch Vehicle (GSLV)

- About**
 - 4th Gen, 3-staged launched vehicle
 - Much more powerful rocket, carries satellites much deeper into space
 - Has an **indigenous Cryogenic Upper Stage**
- Capacity**
 - Delivers **communication-satellites**
 - Carries heavier satellites (~2200 kg to GTO)
 - Carries 10,000-kg satellites to LEO
- Launches Satellites in**
 - Primarily Geosynchronous Transfer Orbit (GTO) (~36000 Km altitude)
- Important Launches:**
 - Chandrayaan-2 Upcoming Gaganyaan



Launch Vehicle Mark-III

- About**
 - Aka **GSLV Mk-III**
 - 3-stage launch vehicle (2 solid propellant and 1 core stage comprising liquid and cryogenic stages)
- Capacity**
 - 4,000-kg of satellites into **GTO**
 - 8,000 kg of payloads into LEO
- Launches Satellites in**
 - GTO Medium Earth orbit (MEO)
 - LEO Missions to moon, sun

Mk-III versions have made ISRO entirely self-sufficient in launching its satellites



Small Satellite Launch Vehicle (SSLV)

- About**
 - Developed specifically for **small and micro-satellites**
- Capacity**
 - Satellites up to 500 kg
- Launch Limit**
 - 500 km **planar orbit (LEO)** from Satish Dhawan Space Centre



Drishiti IAS

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. With reference to India's satellite launch vehicles, consider the following statements: (2018)

- PSLVs launch satellites useful for Earth resources monitoring whereas GSLVs are designed mainly to launch communication satellites.
- Satellites launched by PSLV appear to remain permanently fixed in the same position in the sky, as viewed from a particular location on Earth.
- GSLV Mk III is a four-stage launch vehicle with the first and third stages using solid rocket motors, and the second and fourth stages using liquid rocket engines.

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 2 and 3
- (c) 1 and 2
- (d) 3 only

Ans: (a)

PDF Reference URL: <https://www.drishtiias.com/printpdf/isro-to-launch-lvm3-with-semi-cryogenic-stage>

