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

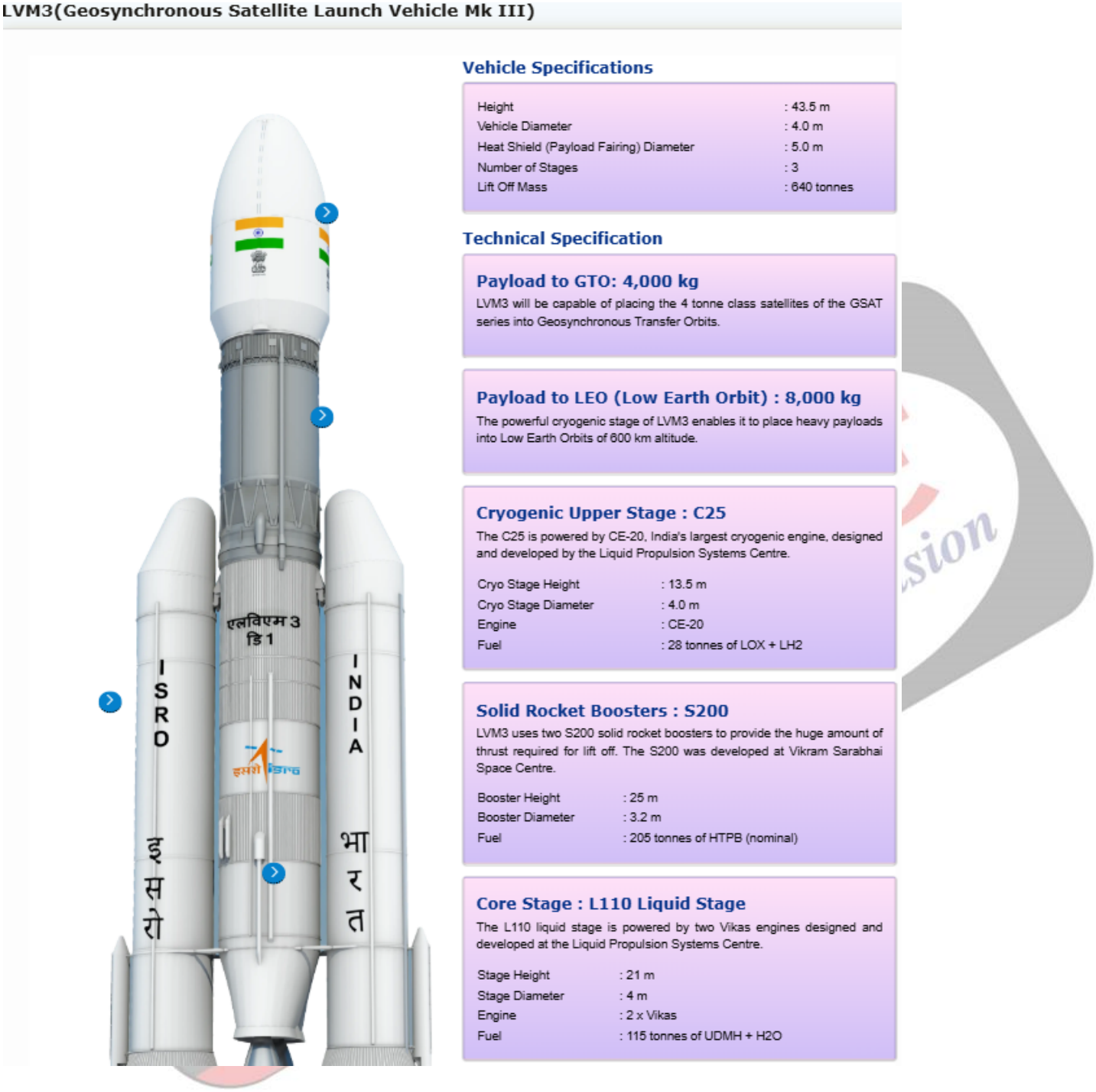
Feature	Cryogenic Engine	Semi-Cryogenic Engine
Fuel	Liquid Hydrogen (LH_2) + Liquid Oxygen (LOX)	Refined Kerosene (RP-1) + Liquid Oxygen (LOX)
Fuel Temperature	LH_2 at −253°C, LOX −183°C	−183°C, Kerosene stored at ambient temperature
Complexity	High (due to handling ultra-cold LH_2, insulation challgengs)	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	- High efficiency (specific impulse -450 sec) - Clean exhaust (water vapor)	- 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 (N_2O_4)**.
  - **Third Stage (Upper Stage)**: The **C25 cryogenic stage** powered by the **CE20 engine**, using **liquid hydrogen (LH_2)** 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.



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

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

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

1. PSLVs launch satellites useful for Earth resources monitoring whereas GSLVs are designed mainly to launch communication satellites.
2. Satellites launched by PSLV appear to remain permanently fixed in the same position in the sky, as viewed from a particular location on Earth.
3. 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)