



## GSLV-F10

**For Prelims:** Geosynchronous Satellite GSLV-F10/EOS-03 mission , Geosynchronous Satellite Launch Vehicle (GSLV), Types of launch vehicles.

**For Mains:** Space Technology, Types of launch vehicles and Related Issues.

### Why in News?

In 2021, a high-level panel was established to examine the [failed Geosynchronous Satellite GSLV-F10/Earth Observation Satellites \(EOS\)-03 mission](#) and recommended measures for making the [Cryogenic Upper Stage \(CUS\)](#) more robust.

- The [Geosynchronous Satellite Launch Vehicle \(GSLV\)](#) with improvements added to its CUS is expected to be ready in the second half of this year.

### What is a Geosynchronous Satellite Launch Vehicle (GSLV)?

- GSLV is a **space launch vehicle designed, developed, and operated by the [Indian Space Research Organisation \(ISRO\)](#)** to launch satellites and other space objects into **Geosynchronous Transfer Orbits**.
  - GSLV has been designed for **launching communication satellites**.
- Geosynchronous satellites are launched into orbit in the **same direction the Earth is spinning and can have any inclination**.
  - The satellites in the geosynchronous orbits appear to **remain permanently fixed in the same position in the sky**.
- GSLV has the capability to put a heavier payload in orbit than the [Polar Satellite Launch Vehicle \(PSLV\)](#).
- It is a **three-stage launcher with strap-on motors**.

### What is Cryogenic Upper Stage?

- GSLV follows a **solid fuel first stage** with another **liquid fuel stage coming next. The second stage is followed by a third stage** known as **CUS**.
  - It was the rocket's **crucial third stage**, which then failed to ignite and led to the **failure of the GSLV-F10**.
- The cryogenic stage is **technically a very complex system compared to solid or earth-storable liquid propellant stages** due to its use of **propellants at extremely low temperatures** and the **associated thermal and structural problems**.

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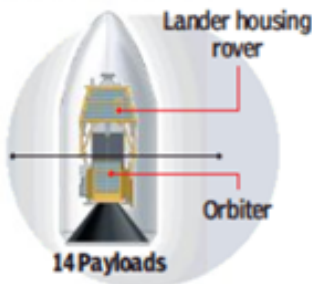
# THE ABC OF CRYOGENIC UPPER STAGE

It took Isro two decades to develop the cryogenic upper stage of GSLV MkIII. The cryo engine gives enormous thrust needed to propel the rocket with 4-tonne payload to geosynchronous transfer orbit

## GSLV MkIII Rocket

Payload fairing

C25 Cryogenic stage



L110 liquid stage Vikas engine

Combustion nozzle

S200 Boosters

The cryo stage carries 28 tonnes of propellants in two tanks that provide a thrust of 20 tonnes

Combustion Chamber

Liquid Hydrogen

Helium Liquid

Helium is used to maintain pressure in cryogenic chambers

Two tanks with liquid hydrogen (at  $-253^{\circ}\text{C}$ ), fuel, and liquid oxygen (at  $-183^{\circ}\text{C}$ ), oxidiser, connected to combustion chamber

Liquid Oxygen

Liquid oxygen and liquid hydrogen from respective tanks are fed by individual booster pumps to main turbopump (at around 40,000 rpm) to ensure a high flow rate of propellants into the combustion chamber

- > Two small steering engines provide for control of stage during its thrusting phase
- > Thrust control and mixture ratio control are

- achieved by two independent regulators
- > Main engine and two steering engines together develop a nominal thrust of 73.55 kN in vacuum

### MAIN PROBLEMS

- > Due to large temperature difference, heat transfer is very high. Therefore, lot of insulation needed
- > Boiling causes sudden pressure rise in tanks. So

- proper venting is required
- > Material properties vary at low temperatures. Most materials become brittle. So if valve seats or seals become brittle and break, it causes leaks

## What are Earth Observation Satellites?

- **Earth observation satellites** are the satellites equipped with **remote sensing technology**.
  - Earth observation is the gathering of information about Earth's physical, chemical and biological systems.
- Many earth observation satellites have been employed on sun-synchronous orbit.
- Other earth observation satellites launched by ISRO include **RESOURCESAT- 2, 2A, CARTOSAT-1, 2, 2A, 2B, RISAT-1 and 2, OCEANSAT-2, Megha-Tropiques, SARAL and SCATSAT-1, INSAT-3DR, 3D, etc.**

### Launch vehicles used by ISRO

Launch vehicles used by ISRO	
<b>Satellite Launch Vehicle (SLV):</b>	<ul style="list-style-type: none"> <li>▪ The first rocket developed by ISRO was simply called <b>SLV, or Satellite Launch Vehicle</b>.</li> <li>▪ It was followed by the <b>Augmented Satellite Launch Vehicle or ASLV</b>.</li> </ul>
<b>Augmented Satellite Launch Vehicle (ASLV):</b>	<ul style="list-style-type: none"> <li>▪ SLV and ASLV both could carry small satellites, <b>weighing up to 150 kg</b>, to lower earth orbit.</li> <li>▪ ASLV operated till the early <b>1990s before PSLV</b> came on the scene.</li> </ul>
<b>Polar Satellite Launch Vehicle (PSLV):</b>	<ul style="list-style-type: none"> <li>▪ PSLV's first launch was in 1994, and it has been ISRO's main rocket ever since. Today it is <b>and several times more powerful than the ones</b> used in the 1990s.                             <ul style="list-style-type: none"> <li>◦ It is the first Indian launch vehicle to be equipped with liquid stages.</li> </ul> </li> <li>▪ PSLV is the <b>most reliable rocket used by ISRO till date</b>, with 52 of its 54 flights being successful.</li> <li>◦ It successfully launched two spacecraft - <b>Chandrayaan-1</b> in 2008 and <b>Mars Orbiter Mission</b> in 2013.</li> </ul>

	<p>later traveled to Moon and Mars respectively.</p> <ul style="list-style-type: none"> <li>◦ ISRO <b>currently uses two launch vehicles - PSLV and GSLV</b> (Geosynchronous) and there are lots of different variants of these.</li> </ul>
<b>Small Satellite Launch Vehicle (SSLV):</b>	<ul style="list-style-type: none"> <li>▪ SSLV is targeted at rising global demand for the launch of small and micro-satellites.</li> <li>▪ SSLV is meant to offer <b>cost-effective launch services for satellites up to 500 kg</b>.</li> <li>▪ It is supposed to carry an indigenous earth observation satellite EOS-03 into space.</li> </ul>
<b>Geosynchronous Satellite Launch Vehicle (GSLV):</b>	<ul style="list-style-type: none"> <li>▪ GSLV is a much <b>more powerful rocket</b>, meant to carry <b>heavier satellites much more than 10,000 kg</b>. The rockets have carried out 18 missions, of which <b>four ended in failure</b>.</li> <li>▪ It <b>can take 10,000-kg satellites</b> to lower earth orbits.</li> <li>▪ The indigenously developed <b>Cryogenic Upper Stage (CUS)</b>, forms the third stage of the rocket.</li> <li>▪ Mk-III versions have made ISRO entirely <b>self-sufficient for launching its satellites</b>. <ul style="list-style-type: none"> <li>◦ Before this, it used to depend on the European Ariane launch vehicle to take the satellite into space.</li> <li>◦ GSLV-Mk III is <b>a fourth generation, three stage launch vehicle</b> with four stages. The indigenously developed CUS, which is flight proven, forms the third stage of GSLV Mk III.</li> <li>◦ The rocket has three-stages with two solid motor strap-ons (S200), a liquid propellant stage (L20) and a cryogenic stage (C-25).</li> </ul> </li> </ul>
<b>Reusable Rockets/ Future Rockets:</b>	<ul style="list-style-type: none"> <li>▪ The future rockets are meant to be reusable. Only a small part of the rocket would be reusable.</li> <li>▪ The bulk of it would <b>re-enter the earth's atmosphere and land very much like a plane</b> after each mission.</li> <li>▪ Reusable rockets would <b>cut down on costs and energy</b>, and also reduce space debris problem because of the large number of launches.</li> <li>▪ <b>Fully-reusable rockets are still to be developed</b>, but partially-reusable launch vehicles are being developed.</li> <li>▪ ISRO has <b>also developed a reusable rocket, called RLV-TD (Reusable Launch Vehicle Technology Demonstrator)</b>, which has had a successful test flight in 2016.</li> </ul>

## UPSC Civil Services Examination, Previous Year Questions (PYQs)

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

1. PSLVs launch the 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-staged 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)**

**Source: TH**

