**GSLV D-5 “the naughty boy of ISRO”**

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***Abstract*** :- two-decade long effort by the Indian Space Research Organization’s (ISRO) successful launch of the Geosynchronous Satellite Launch Vehicle-D5 (GSLV-D5), carrying communication satellite GSAT-14 on 5th Jan 2014. The launch of GSLV D5, which came three years after a failed attempt, paves way for ISRO to launch heavy communications satellites on its own, undertake bigger space missions and also compete globally in satellite launch services. This mission has enabled India to join the “Cryo-club”, a select group of spacefaring nations that possess the crucial cryogenic engine technology necessary to carry heavy satellites into space. Countries which have such a capability are the US, Russia, France, Japan and China.

***Keywords: -***GSLV D5, GSAT, Cryogenic propulsion technology.

**INTRODUCTION**

Indian Space Research Organization’s (ISRO’s) has suc­cessfully launched the Geosynchronous Satellite Launch Vehicle, GSLV-D5 from Sriharikota. It marks a significant achieve­ment of India’s prowess over indigenous cryogenic technology. A 1,000-second flight of India’s heavy rocket, the Geosynchronous Launch Vehicle (GSLV), on January 5 propelled the country into an elite club of spacefaring nations, capping a two-decade long effort by the Indian Space Research Organization (ISRO) in mastering the crucial cryogenic propulsion technology. The launch of GSLV D5, which came three years after a failed attempt, paves way for ISRO to launch heavy communications satellites on its own, undertake bigger space missions and also compete globally in satellite launch services. Currently, a handful of countries including the United States, France, Russia and China dominate the market for launching large satellites and ISRO has been relying on foreign launch services in adding more transponder capacity to meet growing domestic demand.

**SOME WORDS….**

**“I am proud to say ISRO has done it. The Indian cryogenic engine and stage performed as predicted, as expected, for this mission and injected precisely the GSAT 14 communications satellite into the intended orbit,”**

**By K. Radhakrishnan chairman of ISRO.**

**“We used to call GSLV as the naughty boy of ISRO. The naughty boy has become obedient and, today has meticulously done its job, The 1,000 seconds of the GSLV flight we just had is the fruit of 1,000days of hard, dedicated work of the team,”**

**By Sivan, project director .**

**HISTORY**

1. India has depended on the United States and Europe for the launch of INSAT class of satellites.
2. Russia backed out of the deal after US sanctions were imposed in May 1992. ISRO started the Cryogenic Upper Stage Project in April 1994 and began developing its own cryogenic stage.
3. The first development flight of GSLV Mk. I (GSLV-D1) was launched on 18 April 2001.The flight carrying GSAT-1 failed to reach the correct orbit.
4. The GSLV became operational after a second development flight, which successfully placed GSAT-2 in 2003. In its first operational flight in September 2004, GSLV launched EDUSAT. India's first dedicated satellite for educational services.
5. The second operational flight, GSlV-F02, conducted on July 10, 2006 did not succeed in placing the satellite INSAT 4C into orbit.
6. GSLV-F04 is the fifth flight of India's Geosynchronous Satellite Launch Vehicle (GSLV), launched INSAT-4CR satellite, into a Geosynchronous Transfer Orbit (GTO) of 170 km perigee and 35,975 km apogee with an orbital inclination of 21.7° with respect to the equator on September 2, 2007.
7. Two launches in 2010 failed; the first, in April 2010, was the first flight of the GSLV Mk.II, with an Indian-developed third stage engine replacing the Russian engine used on earlier flights.
8. GSLV-D5, launched on January 5, 2014, was the first successful flight of the GSLV Mark.II using the indigenously developed cryogenic engine, the CE-7.5.

**GSLV-D5**

It is the eighth flight of India’s Geosynchronous Satellite Launch Vehicle (GSLV). It is also the fourth developmental flight of GSLV. During this flight, the indigenously developed Cryogenic Upper Stage (CUS) will be flight tested for the second time. GSLV-D5 has launch 1982 Kg GSAT-14, a communication satellite, into Geosynchronous Transfer Orbit (GTO). After reaching GTO, GSAT-14 has use its own propulsion system to reach its geostationary orbital home and will be stationed at 74º East longitude.

**How Its Works?**

The GSLV is a three-stage vehicle with solid, liquid and cryogenic propulsion systems.

1. **First stage**

GSLV-D1 used the S125 stage which contained 125 tonnes of solid propellant and had a burn time of 100 seconds. All subsequent launches have used enhanced propellant loaded S139 stage .The S139 stage is 2.8 m in diameter and has a nominal burn time of 109 seconds .The stage generates a maximum thrust of 4700kN.

1. **Second stage**

The GS2 stage is powered by the Vikas engine. It has 2.8 m diameter.

1. **Third stage**

The third stage of the GSLV Mk.II is propelled by the CE-7.5, an indigenous cryogenic rocket engine, 2.8 m in diameter and uses liquid hydrogen (LH2) and liquid oxygen (LOX).The indigenous cryogenic engine was built at the Liquid Propulsion Systems Centre in Mahendragiri, Tamil Nadu.

**TECHNOLOGY USED.**

Indigenous Cryogenic Engine

A Cryogenic rocket stage is more efficient and provides more thrust for every kilogram of propellant it burns compared to solid and earth-storable liquid propellant rocket stages. Specific impulse (a measure of the efficiency) achievable with cryogenic propellants (liquid Hydrogen and liquid Oxygen) is much higher compared to earth storable liquid and solid propellants, giving it a substantial payload advantage. Oxygen liquefies at –183 deg C and Hydrogen at –253 deg C. The propellants, at these low temperatures are to be pumped using turbo pumps running at around 40,000 rpm. The main engine and two smaller steering engines of CUS together develop a nominal thrust of 73.55 kN in vacuum. During the flight, CUS fires for a nominal duration of 720 seconds. Liquid Oxygen (LOX) and Liquid Hydrogen (LH2) from the respective tanks are fed by individual booster pumps to the main turbopump to ensure a high flow rate of propellants into the combustion chamber.

**GSAT-14**

SAT-14 is the twenty third geostationary communication satellite of India built by ISRO. Four of GSAT-14’s predecessors were launched by GSLV during 2001, 2003, 2004 and 2007 respectively. After its commissioning, GSAT-14 has join the group of India’s nine operational geostationary satellites.

The main objectives of GSAT-14 mission are:

1. To augment the in-orbit capacity of Extended C and Ku-band transponders
2. To provide a platform for new experiments .The cuboid shaped GSAT-14 has a lift-off mass of 1982 kg and the dry mass of the satellite is 851 kg. GSAT-14 structure is based on ISRO’s 2 ton class platform (I-2K satellite bus). The two solar arrays (each with two panels) of GSAT-14 together generate about 2600 W of power, while the light weight Lithium-Ion Batteries supply power during eclipse period.GSAT-14 will be positioned at 74 deg East longitude and co-located with INSAT-3C, INSAT-4CR and KALPANA-1 satellites. The 12 communication transponders on board GSAT-14 will further augment the capacity in the INSAT/ GSAT system.

**FEATURES**

The features Of GSLV D-5 are as follows…

1. Cost :- 350-crore Rs.
2. Overall Height :- 49.13 metre.
3. Lift-off Mass :- 414.75 Ton.
4. Lift-off Thrust :- 6773 kilo Newton.
5. No. of Stages :- 3.
6. Perigee :- 180 ± 5 km.
7. Apogee :- 35975 ± 675 km.
8. Inclination :- 19.3 ± 0.1 deg.
9. Engines :- CE-7.5.
10. Burn time :- 720 seconds.

**FUTURE PLAN**

1. GSLV Mk-3
2. GSLV - D6(Future)
3. GSLV - F08
4. GSLV – F09
5. Chandrayan -2.
6. GSLV Mk.3

**ADVANTAGES**

1. India has Joined the “Cryo-club”
2. It made India Independents in Satellite.
3. Saving Money. (Around 400 Crore)
4. India Can launched foreign satellite.
5. Earn Money.(Around 600 Crore.
6. Can carry 2000 -2500kg weight.

**CONCLUSION**

The Indian Space Research Organisation or ISRO achieved another milestone on January 5, 2014, as it successfully launched the Geo-synchronous Satellite Launch Vehicle or GSLV-D5 from the Satish Dhawan Space Centre at Sriharikota in Andhra Pradesh. The advanced GSAT-14 communications satellite that the rocket was carrying has also been placed into orbit.

**“The naughty boy has become obedient and, today has meticulously done its job.” by Sivan, project director.**

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