LVM3-X/CARE MISSION

LVM3 X FLIGHT

CARE

Objectives

- Flight validation of the complex atmospheric flight regime of LVM3 Vehicle
- Validation of new design features
- Overall integrity of the mission design, simulation and software implementation
- Study the re-entry characteristics of crew module CARE





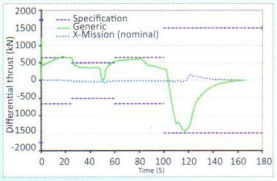
GSLV Mk-III Project

Vikram Sarabhai Space Centre
Thiruvananthapuram

New Systems & Features qualified through LVM3-X flight

Demonstration of Paired S200 boosters

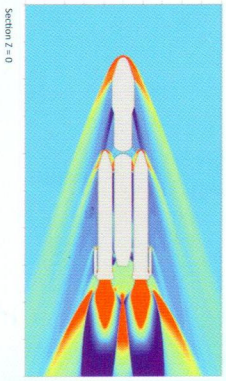




Differential thrust bounds & predicted value

- S200 motors are cast with paired / sim sorted propellants to control differential thrust
- To demonstrate the controlled burn rate dispersion bounds on this pair motors

Validation of baseheating & Aerothermal design



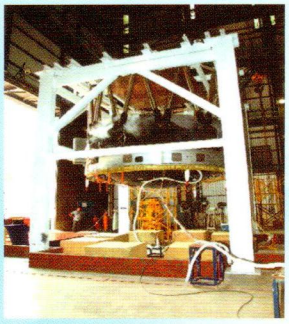
- Complex flow fields with 2 S200 + 2 L110 engines
- Reverse flow at about 85 s
- Thermal design of base region
- L110 Nozzle closure performance

Jettisoning motor assisted S200 separation



- Pitch down mode of S200 separation
- 6 Jettisoning motors on each S200 stage, 3 on Nose cone and 3 on Base shroud
- Circular FLSC based forward and aft separation links

Active/Passive Collet based L110 separation





- Active / Passive collet concept for L110 separation
- 2 stage separation of collets

L110 Separation Test

- Long pullout C25 engine with separation motor assistance
- Initial part guided in collet for about 90 mm

Important New Developments for LVM3

- Full redundancy for Control actuation systems
- Tripple Modular Redundancy (TMR) for sequencing
- Independent Telecommand system for each stage
- New Separation system for S200/L110/Spacecraft/PLF (Payload Fairing)
- Tension Release device for PLF & Spacecraft Separation system
- New Modified Polymer Bondex Explosive (MPBX) based destruct system for all stages

LVM3-X/CARE MISSION

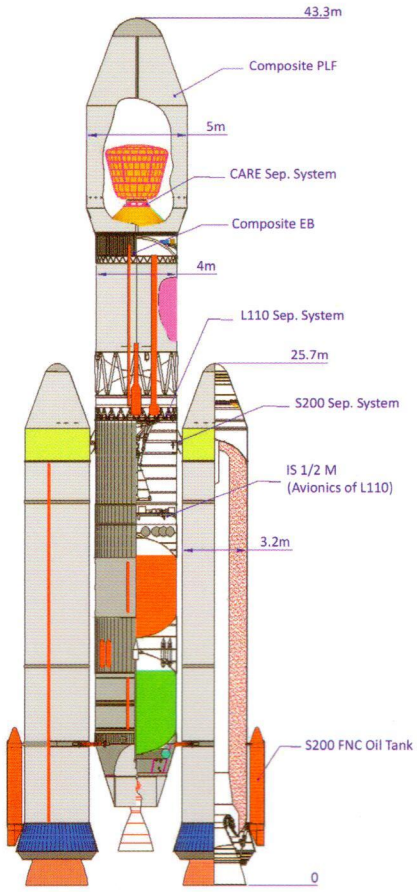
The experimental flight of LVM3 designated as LVM3-X will carry CARE (Crew module Atmospheric Reentry Experiment) as its payload. In the LVM3-X flight active S200 and L110 propulsive stages, and a passive C25 stage with dummy engine are used. The C25 stage uses all flight identical structures and interfaces. The LOX and LH_2 tank are filled with Liquid Nitrogen (LN_2) and Gaseous Nitrogen (GN_2) respectively. The external vehicle configuration is identical to that of LVM3-D1 which is the generic vehicle configuration. The Payload Fairing and Spacecraft separation systems are also functional. The mission is designed to provide a suitable altitude, velocity and flight path angle to CARE at separation.

LVM3-X Vehicle Characteristics	
Vehicle Height	43.43 m
Lift off Mass	630.58 t
Stages	
2 S200	Two Solid propelled strap-on motors (207 t of propellant)
L110	Liquid propellant core booster
C25-X	Cryogenic upper stage (passive)

LVM3-X Mission Specifications	
Altitude	126 ± 1 km
Velocity	5325 ± 20 m/s
Flight path angle (local)	0 ± 0.1deg
Launch Pad	Second Launch Pad
Launch Azimuth	120°

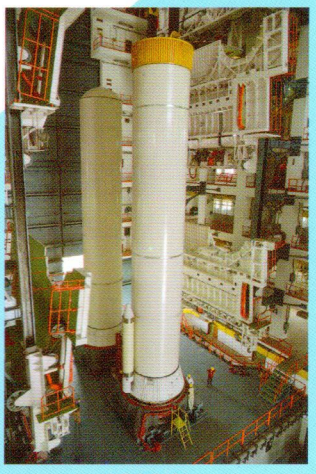
The configuration of vehicle for LVM3-X mission:

2S200+L110+C25-X



LVM3 - X Vehicle Configuration

FLIGHT STAGES



S200 Stage



L110 Stage

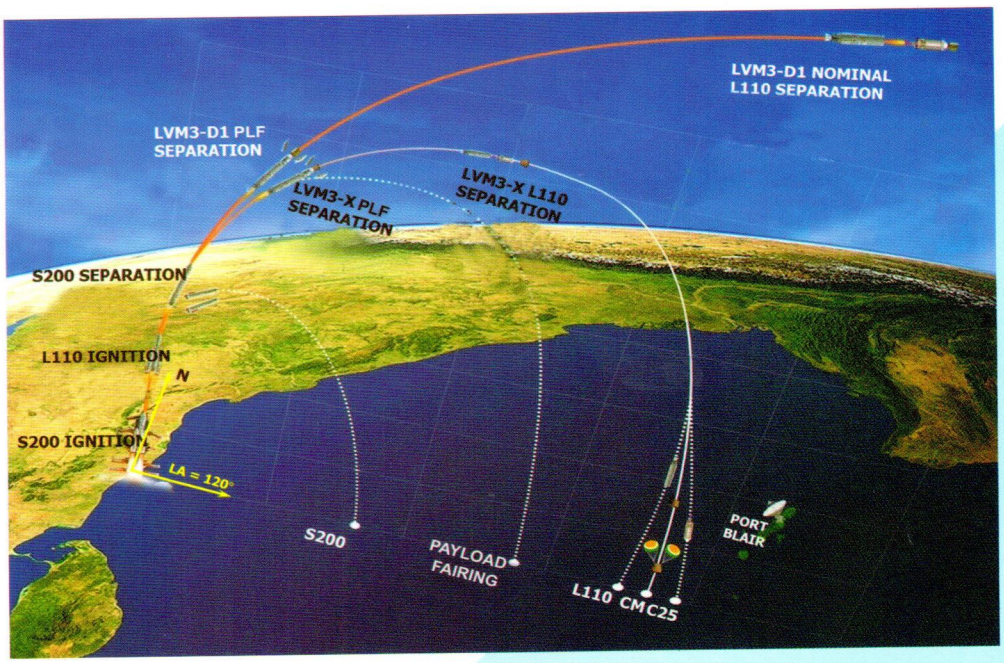


C25 Passive Stage

LVM3-X Stage Characteristics			
Parameters	Stages		
	S200	L110	C25-X
Length (m)	25.75	21.26	13.32
Diameter (m)	3.2	4.0	4.0
Propellants	HTPB	N_2O_4 & UH25	LN_2 (for mass simulation)
Propellant mass (t)	207	115	15
Stage mass at Lift off (t)	238	125.6	18.3

TEST FLIGHT SEQUENCE

The overall flight sequence is given highlighting the planned time, altitude and inertial velocity at critical events. Flight sequence up to L110 burnout will be identical to LVM3-D1 flight. The flight sequence from L110 burnout onwards are modified to implement the remaining commands to be issued till spacecraft separation and post spacecraft injection manoeuvres.



FLIGHT PROFILE

LVM3-X/CARE Mission Flight Events				
Events	Time (s)	Altitude (km)	Inertial Velocity (m/s)	Flight Path Angle (deg)
S200 Ignition	0.00	0.02	451.92	90.00
L110 Ignition	114.71	43.43	1785.98	63.15
S200 Separation	148.98	70.81	2124.96	69.79
PLF Separation	232.70	114.35	3136.91	84.32
L110 Shutoff	317.62	126.24	5285.59	89.88
L110 Separation	320.42	126.25	5326.52	90.01
C25 Shutoff (Dummy command)	321.52	126.24	5326.53	90.07
CARE Separation	325.52	126.16	5326.66	90.29

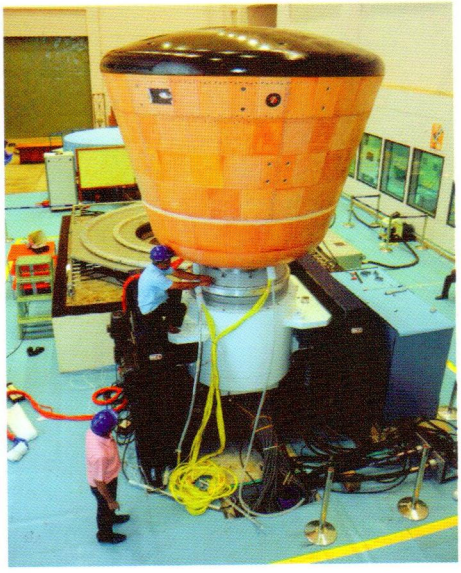
CARE (Crew module Atmospheric Reentry Experiment)

Crew Module (CM) is identified as the payload in LVM3-X/CARE Mission. CARE is the acronym for Crew Module Atmospheric Re-entry Experiment. The mission would be used as a platform for testing the re-entry technologies envisaged for Crew Module including validating the performance of parachute based deceleration system. CARE is expected to enhance the understanding of blunt body re-entry aerothermodynamics and parachute deployment in cluster configuration.

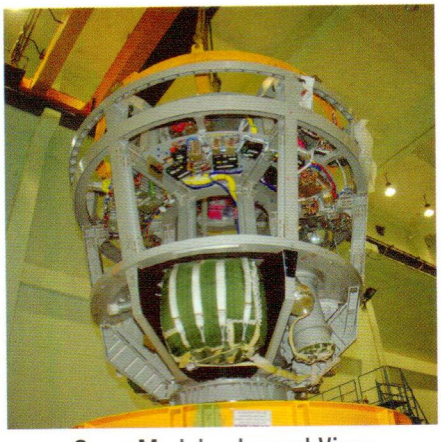
The external configuration of the Crew Module to be flight tested in LVM3 is same as that of manned flight.

Objectives:

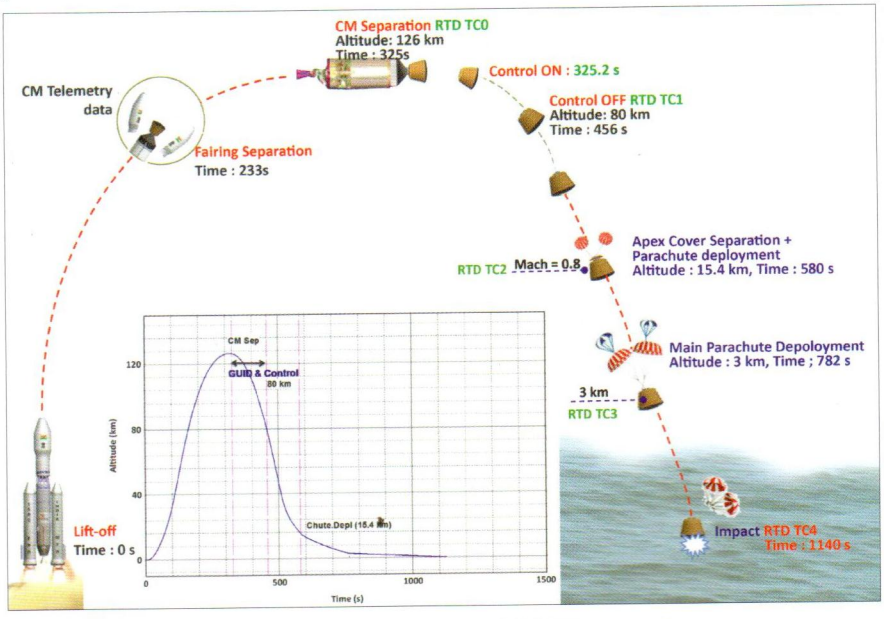
- Demonstration of reentry flight of Crew Module
- End to end parachute system validation
  - Demonstration of apex cover separation
  - Demonstration of parachute deployment



Crew Module on vibration table



Crew Module - Inernal View



Flight sequence of CARE separation

Salient features		
Configuration	Lift Off Mass	: 3735 kg
	Overall size	: Base dia : 3.1m Height : 2.7m
	Aluminium alloy metallic structure with CFRP panels	
Thermal protection System	Side panels and apex cover Medium Density Ablative (MDA) tiles; forward heatshield with Carbon phenolic tiles.	
RCS 6no.s	100N thruster with MMH and MON3 propellants	
Deceleration System	Two independent chain of parachutes consisting of pilot parachute (2.3m dia); drop chute (6.2m dia), and main chute (31m)	
NGC	3 axis controlled upto re-entry with mini resins for navigation and 100N thrusters for Control.	

The Crew Module (CM) is separated from the Launch Vehicle at an altitude of 126 km, re-enters Earh's atmosphere at about 80 km and descends further in ballistic mode. Beyond 80 km, CM follows an uncontrolled re-entry trajectory and impacts at sea about 180 km from Andaman and Nicobar Island from where it will be recovered by Indian Coast guard.