

GAGANYAAN TEST VEHICLE TV-D1

Test platform for validation of
Crew Escape System

Mission Definition:

“In-flight Abort Demonstration of Crew Escape System (CES)” at Mach number 1.2 with the newly developed Test Vehicle followed by Crew Module separation & safe recovery.

Mission Objectives:

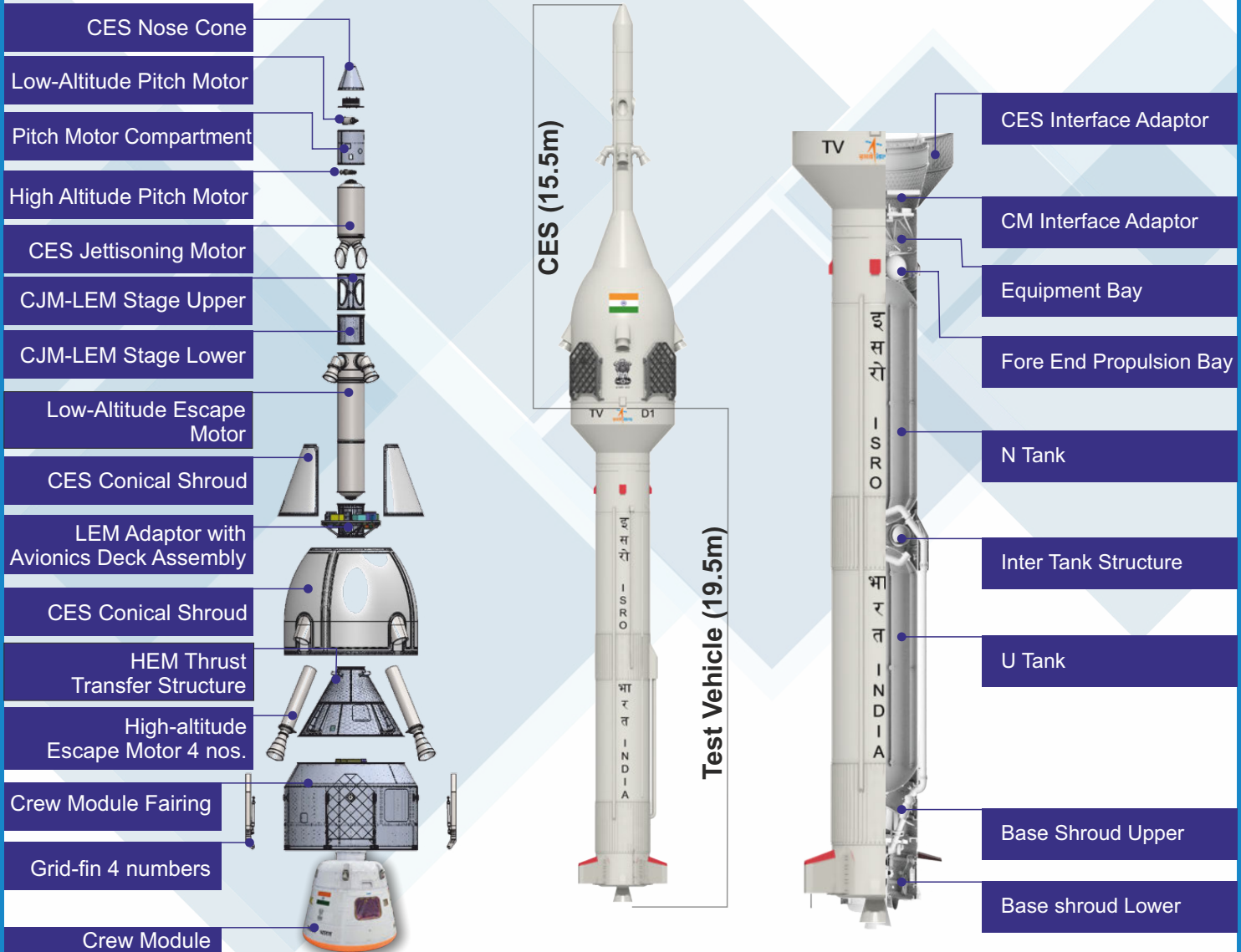
- Flight demonstration and evaluation of Test Vehicle sub systems.
- Flight demonstration and evaluation of Crew Escape System including various separation systems.
- Crew Module characteristics & deceleration systems demonstration at higher altitude & its recovery.

Mission Highlights

| | |
|-----------------------------|---|
| TV Mission Pillbox | <ul style="list-style-type: none">▶ Mach 1.2▶ Altitude 11.7km▶ Flight path angle 60°▶ Dynamic Pressure 22.6kPa |
| CM-CES separation | <ul style="list-style-type: none">▶ Mach 0.5▶ Altitude 17km▶ Dynamic pressure 2-3kPa |
| Drogue Parachute deployment | <ul style="list-style-type: none">▶ Altitude 16.7km |
| Main Parachute | <ul style="list-style-type: none">▶ Altitude < 2.5km |

TV-D1 Vehicle

The Liquid propelled single stage Test Vehicle uses a modified VIKAS engine with Crew Module (CM) and Crew Escape System (CES) mounted at its fore end.



Vehicle Configuration

Length : 34.954m
Diameter : $\text{\O} 2.1\text{m}$ (stage)
 $\text{\O} 4.05\text{m}$ (CES)
Liftoff mass : 44T
TV inert mass : 7T
CES inert mass : 12.5T
CM inert mass : 4.5T



Test Vehicle



CMIA (Crew Module Interface Adaptor)



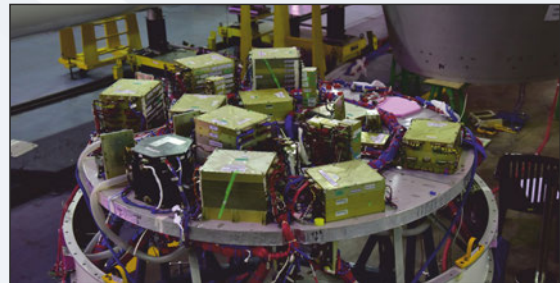
CSIA (CM-CES Interface Adaptor)

Propulsion System

TV : VIKAS Engine with AR6
 $\text{N}_2\text{O}_4 - 12\text{T}$
UH-25 - 7T
CES : HEM (4 nos.) + CJM



Crew Module Fairing with Grid Fins



Test Vehicle Equipment Bay (TEB)



Test Vehicle Base Shroud Lower (TBSL)

Major vehicle Sub-Systems Tests



AR 6 VIKAS Engine hot tests



Actuator-in-Loop Simulation Test



Integrated structural test of Interface Adapters



Aero-elastic Test



Cold Gimbal Test



Integrated Base Shroud Acoustic test



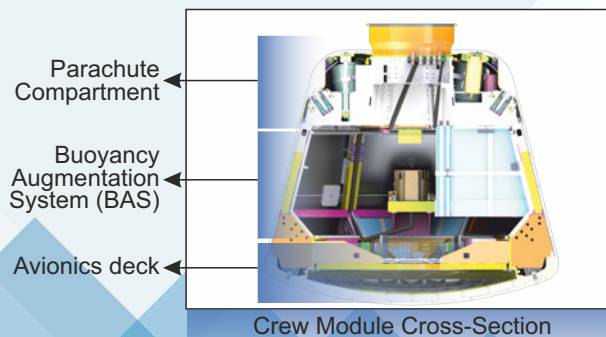
Equipment Bay vibration test



CES Ground Resonance Test

TV-D1 Crew Module (CM)

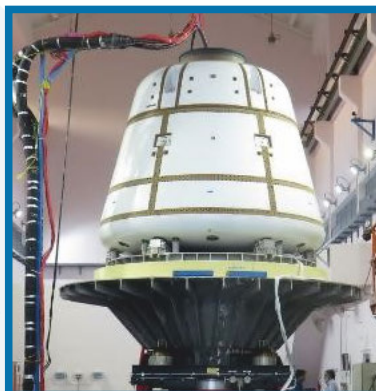
| Specifications | |
|---------------------|---|
| Structure | Single walled unpressurised aluminium structure Simulated thermal protection system using cork |
| Dimensions | Ø3.1m x 2.97m |
| Mass | 4520 kg |
| Avionics | Launch Vehicle heritage with dual redundancy |
| Navigation | Mini Advanced INS augmented by NavIC/ GPS |
| Deceleration system | Total of 10 parachutes with pyro systems. Parachute deployment Initiation at 17 km altitude |
| Separation Systems | <ul style="list-style-type: none">• CM/SM separation• CM/CES separation• Apex cover separation• CES - CMF separation |
| Touch down velocity | 8.5 m/s (Nominal) |
| Floataction system | Buoyancy augmentation system using PUF blocks |
| Recovery aids | Sea markers and location transmitter |



Crew Module Sub-Systems Tests



Crew Module Acoustic Test
at ISITE, URSC



Crew Module Vibration Test
at SDSC, SHAR



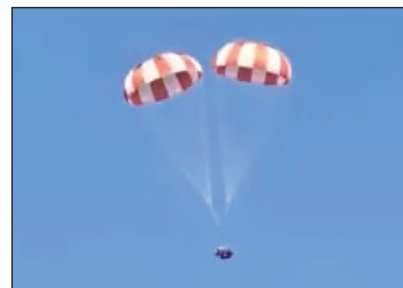
Service Module separation test



Crew Escape System separation test



Apex Cover separation test



4 Main Parachute Air drop tests
conducted using AN32 & IL76
at ADRDE, Agra & BFFR, Jhansi

Crew Escape System (CES)

Crew Escape system consists 5 types of quick acting solid motors namely Crew Escape System Jettisoning Motor (CJM), High-altitude Escape Motor (HEM), Low-altitude Escape Motor (LEM), Low-altitude Pitch Motor (LPM) and High-altitude Pitch Motor (HPM) with PEDCEM formulation, which generate required acceleration for varying mission requirements.

Qualification of Solid Motors

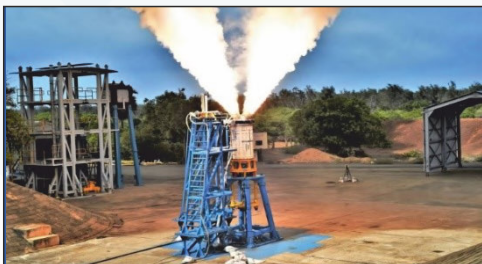


Low-altitude Escape Motor (LEM) Static Test

| | |
|------------------------|---------|
| Propellant Mass [Kg] | : 2098 |
| Max Vacuum thrust (kN) | : 875.1 |

High altitude Escape Motor (HEM) Static Test

| | |
|------------------------|---------|
| Propellant Mass [Kg] | : 271 |
| Max Vacuum thrust (kN) | : 260.7 |



CES Jettisoning Motor (CJM) Static Test

| | |
|------------------------|---------|
| Propellant Mass [Kg] | : 2098 |
| Max Vacuum thrust (kN) | : 875.1 |

Qualification of Parachutes



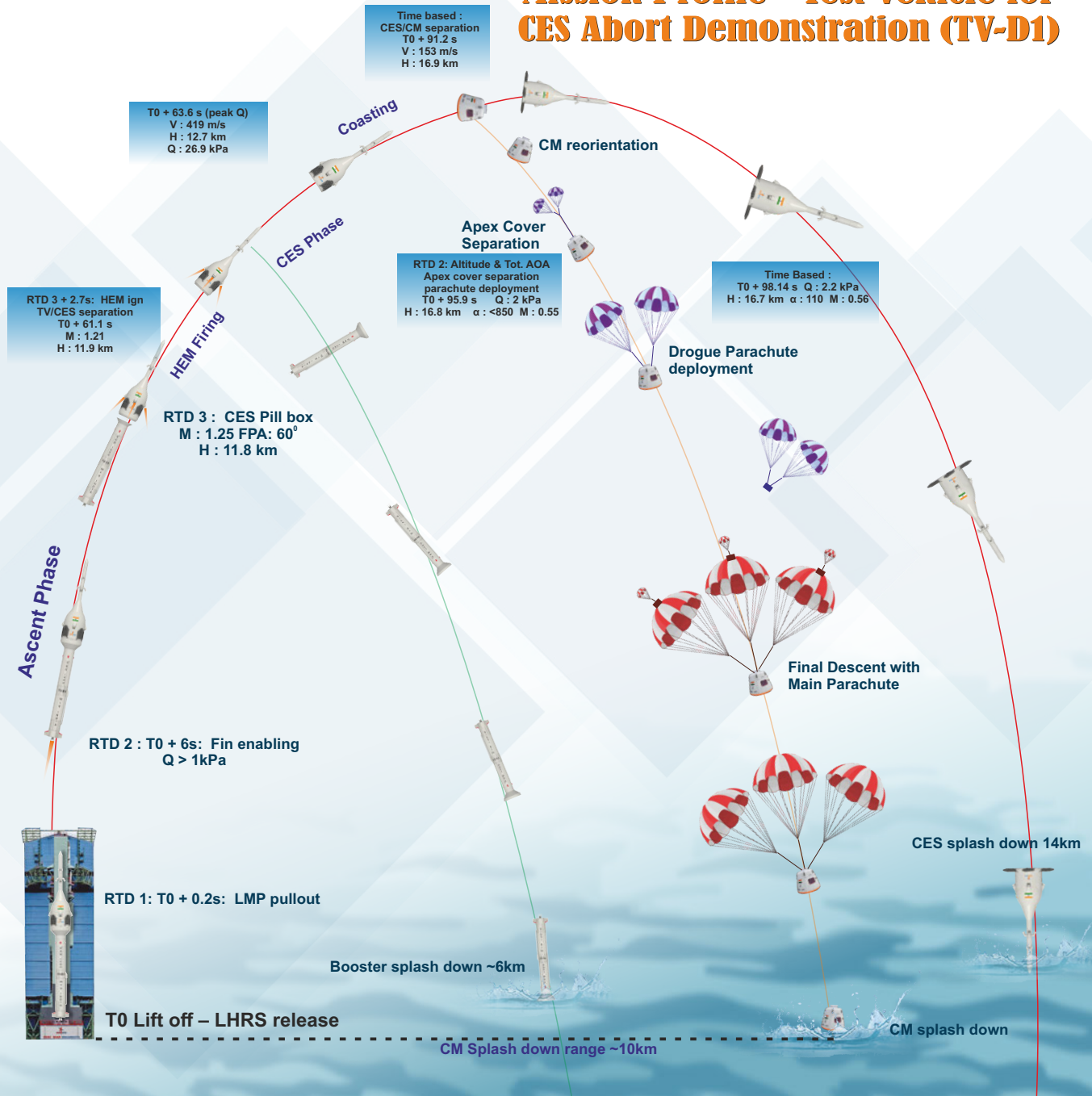
12 Qualification tests conducted for Drogue, Pilot & Apex cover parachutes using Rail Track Rocket Sledge [RTRS] system at TBRL, Chandigarh

Crew Module Recovery Trials

Indian Navy team will lead the recovery of TV-D1 Crew Module after touchdown, approximately 10 km from Sriharikota coast. Recovery ships positioned at a safe range in sea waters will approach the Crew Module and a team of divers will attach a buoy, hoist the Crew Module using a ship crane and bring to the shore.



Mission Profile - Test Vehicle for CES Abort Demonstration (TV-D1)



TV-D1

Flight Events

| Events | Flight Time (s) | Altitude (km) | Relative velocity (m/s) |
|--|-----------------|---------------|-------------------------|
| Ignition | -6.00 | 0.0 | 0.0 |
| Lift-off | 0.00 | 0.0 | 0.0 |
| TV-CES separation | 60.6 | 11.7 | 363 |
| CM-CES separation | 90.6 | 16.7 | 147 |
| Mortar Ign. for ACS Parachute deployment | 95.9 | 16.6 | 148.7 |
| Apex Cover Separation | 96.2 | 16.6 | 149.3 |
| Mortar Ign. for Drogue Parachute deployment | 98.2 | 16.5 | 152 |
| Drogue Parachute release | 296.1 | 2.4 | 62.8 |
| Mortar Ign. for Pilot Parachute Deployment | 296.3 | 2.38 | 64.1 |
| Main Parachute Deployment | 296.5 | 2.37 | 64.1 |
| CM Touchdown | 531.8 | 0.0 | 8.5 |



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