

EAR HISPASAT-1F D1039566

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H1F End of Life Disposal Plan

The plan for disposing of the H1F satellite at end of life ensures that all stored energy sources on board the satellite are discharged to the maximum extent practicable, by venting excess propellant, discharging batteries, relieving pressure vessels, and all other appropriate measures.

A) The following sequence describes the process flow, rather than detail, with emphasis on what we are achieving and the main considerations.

1. Starting point

All payload ground station Uplink traffic is off.

Bus systems are normal (Attitude Control / Data Handling / Power / Propulsion).

Satellite is at or near Geosynch orbit.

2. Deactivate Payload

Turn off all payload units including TWTA's, LCAMP's, LNA's, Downconverters, Beacons, MLO's & MRO's. This will ensure no Payload RF radiation will interfere with other spacecraft.

3. Configure TT&C

Establish High Power Wide Angle Telemetry and Command mode by command.

HPWA is established prior to the first de-orbit maneuver to obtain a wider FOV as the orbit is raised.

4. Perform Deorbit Maneuvers

SPT de-orbit will be performed if launched on Falcon and Bi-Prop Deorbit maneuvers will be performed if launched on Proton. Both methods are described belows.

Biprop Deorbit

The EOL deorbit maneuver consists of two ΔV s (one at each apsis) in the direction of motion which raise the satellite into a circular orbit above synchronous radius. Attitude is nominal on-orbit. Two ΔV s of approximately 7.5 m/s each raise the EOL circular orbit radius by approximately 414 km above synchronous. The maneuver may have to be divided in several part to observe the total thruster on-time limit of approximately 5 minutes imposed by the propellant management device (PMD). After the completion of the deorbit, go to Sun Acquisition to deplete the remaining bi-propellant and Xenon from the tanks.

SPT Deorbit

Prior to the start of deorbit, attitude should be as follows: S/C +X axis points to Earth at all times. S/C +Z axis points in general direction of motion. S/C is biased in roll to minimize SPT thrust vector angle to orbit plane while maintaining a maximum sun angle of 23.5° to S/C X-Z plane. Roll bias is positive when firing between 12:00-24:00 SLT and negative between 00:00-12:00 SLT. Attitude reorientation, required between each burn, is performed with wheels. Starting the deorbit maneuvers at apogee is optimal. A minimum in-plane acceleration of $21.1 \times 10^{-6} \text{ m/s}^2$ is required to stay out of $\pm 0.10^\circ$ box. A number of SPT firings (approximately

16 firings) are needed to reach the required $\Delta V = 15.0$ m/s. The time to reach the graveyard orbit is approximately 8 days. As in the Biprop case, after the completion of the deorbit, go to Sun Acquisition to deplete the remaining bi-propellant and Xenon from the tanks.

5. Make Satellite Safe

Fire Unused Pyro's

Fire all unfired pyros (Solar Array and Reflector hold downs, propellant system, etc.)

SPT Propulsion System

If, after the disposal orbit is achieved, there is still Xenon remaining in the tank the excess Xenon can be vented by firing SPTs in sun acquisition mode causing the satellite to spin around its X-axis until the gas is expended.

Depressurize Bi Propulsion System & He Pressurant

After the Xenon has been vented and any orbital circularization/cleanup activity by the biprop system, activate all 6 anti earth deck thrusters until all six thrusters temperature drop, indicating there is only one propellant type remaining.

After H1F reaches its final disposal orbit all propellant line valves, located downstream the propellant tanks, will be left open and all pressure vessels will be vented.

Once it has been determined that only one propellant is remaining, repressurize the Ox and Fuel tanks to depressurize He from Pressurant tank to lowest practicable pressure. After repressurizing the propellant tanks, the He isolation valve, located upstream the propellant tanks, is closed to preclude any possibility of residual bipropellants from leaching into the pressurant system and causing a hypergolic reaction. Then activate all 12 thrusters until all 12 indicate fuel and ox depletion (sputtering).

Following these operations, the remaining He will be less than 0.01 kg in the pressurant tanks (three tanks of 49.1 liters each) and 0 kg in the propellant tanks; the remaining Oxidizer (NTO) and Fuel (MMH) in the corresponding tanks is considered negligible. As indicated before, the propellant line valves downstream the propellant tanks will remain open.

6. Spin Down Momentum Wheels

Remaining ACS is not shut down so that the satellite will remain in Sun Acquisition mode when power from the S/A activates the bus. The momentum wheels are spun down before going into sun acquisition mode to reduce the spacecraft "stiffness", thus, minimizing the pressurant required to transition the spacecraft to Sun Acquisition mode.

7. Deactivate Electrical Power System

Turn OFF all the Battery Chargers to keep the batteries from recharging. Open Battery Relays to further preclude the ability to recharge the batteries. Turn OFF all Battery Power Control Unit Dischargers to ensure no battery power is applied to the bus. Deplete charge from all batteries.

As long as the solar arrays can produce enough power when illuminated by the sun, the S/C processors will attempt to reboot in Sun Acq mode whenever 100V power is available from the

arrays; when the array power goes away, and with the batteries depleted, everything will turn off again.

8. Disable Telemetry and Tracking System

Command Off Telemetry transmitter 1 and 2 to ensure no RF radiation will interfere with other spacecraft.

9. End of Satellite Life

B) End-of-Life Deorbit

The End-of-Life (EOL) deorbit maneuver consists of two to four delta-V maneuvers, twelve hours apart if using Bi-prop; multiple firings may be needed so that as bi-prop is used up the orbit can be circularized using bi-prop. If de-orbiting using SPTs, a continuous firing with one or two SPTs is used to provide the necessary delta V. In either case, the delta Vs are in the direction of motion which raises the satellite into a circular orbit above synchronous radius (as shown in Figure 1. Total delta Vs of approximately 15 m/s raise the EOL circular orbit radius greater than 400 km above synchronous. Any excess helium pressurant in the propellant tank can also be used for part of the EOL deorbit maneuver in order to help deplete it if necessary.

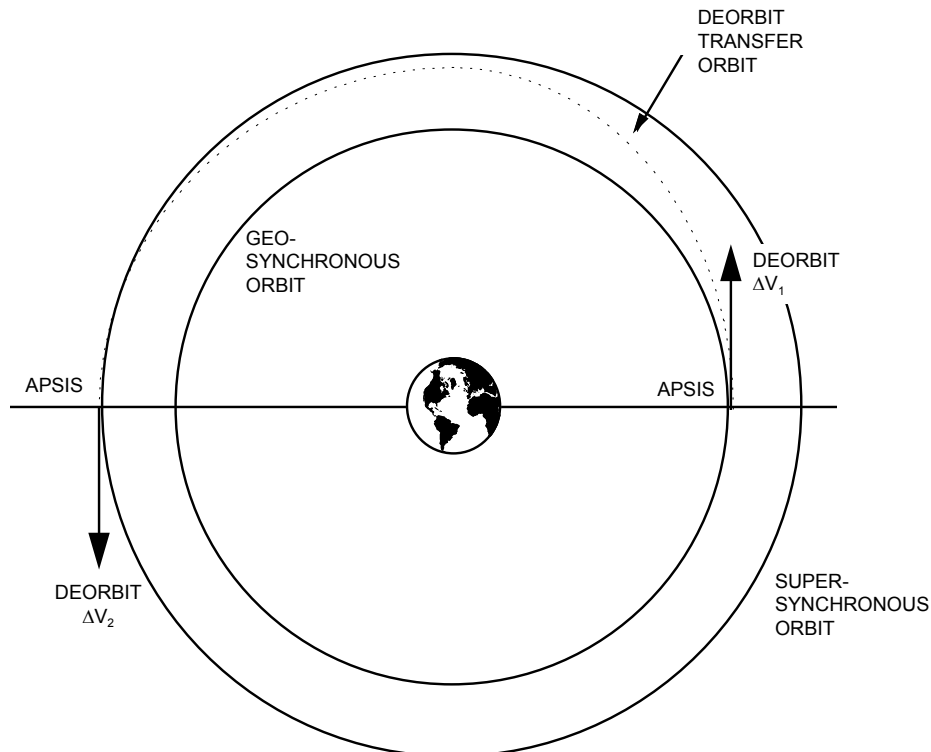


Figure 1. End-of-Life Deorbit Geometry