telenor | satellite

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Mitigation of Orbital Debris

Spacecraft Hardware Design
Telenor Satellite AS, which was responsible for the design, manufacture and operation of the THOR7 satellite, has assessed and limited the amount of debris released in a planned manner during normal operations.

No debris is generated during normal on-station operations, and the spacecraft is in a stable configuration.

Telenor has also assessed and limited the probability of the orbital location becoming a source of orbital debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal. The design of the THOR7 satellite locates all sources of stored energy within the body of the structure, which provides protection from small orbital debris.

Telenor requires that spacecraft manufacturers assess the probability of micrometeorite damage that can cause any loss of functionality. This probability is then factored into the ultimate spacecraft probability of success. Telenor has taken steps to limit the effects of any collisions through shielding, the placement of components, and the use of redundant systems.

Minimizing Accidental Explosions:
The LS1300 satellite was designed and manufactured by Space Systems/Loral. Telenor has assessed and limited the probability of accidental explosions during and after completion of mission operations.

The design of the LS1300 spacecraft is such that the risk of explosion is minimized both during and after mission operations. In designing and building the spacecraft, the manufacturer took steps to ensure that debris generation will not result from the conversion of energy sources on board the satellite into energy that fragments the satellite. All propulsion subsystem pressure vessels, which have high margins of safety at launch, have even higher margins in orbit, since use of propellants and pressurants during launch decreases the propulsion system pressure. Burst tests are performed on all pressure vessels during qualification testing to demonstrate a margin of safety against burst. Bipropellant mixing is prevented by the use of valves that prevent backwards flow in propellant and pressurization lines. All pressures, including those of the batteries, are monitored by telemetry.

Safe Flight Profiles
Telenor has assessed and limited the probability of THOR7 becoming a source of debris by collision with large debris or other operational spacecraft.
Specifically, Telenor has assessed the possibility of collision with satellites located at, or reasonably expected to be located in the vicinity of THOR7.

	IS 10-02	THOR6	THOR5	THOR7
Location	1.0°W	0.85°W	0.75°W	0.65°W
Variation ±	± 0.05°	± 0.05°	± 0.05°	± 0.05°

Telenor uses longitudinal separation for co-location. On-station operations are kept within +/- 0.05 degrees for N-S station-keeping and +/- 0.05 degrees for E-W station-keeping, thereby ensuring adequate collision avoidance distance from other satellites.

Telenor uses Jspoc to monitor the risk of close approach of its satellites with other objects. If required, avoidance maneuvers are performed to eliminate the possibility of collisions.

Telenor Satellite
M3A Snarøyveien 30
N-1331 Fornebu, Norway
Org.no 974 529 068 MVA

Tel +47 67 89 00 00
Fax +47 67 89 36 29
Email sbcsales@telenor.com
Web www.telenorsat.com

Post Mission Disposal Plan

At the completion of its mission, THOR-7 will be removed from its geostationary orbit at 0.65 W.L. to a perigee altitude no less that 262.4 km above the standard geostationary orbit of 35,786 km. This post–disposal perigee takes into account gravitational and solar radiation pressure that could alter the satellite orbit in the years after decommissioning. Telenor Satellite has planned the tracking telemetry and control transmissions required for the end of life repositioning so as to avoid electrical interference to other space stations, and will coordinate with any potential affected satellite networks. Further, in accordance with Section 25.283(c), the minimum post-mission disposal altitude above the geostationary-Earth orbit (i.e.,minimum perigee) is calculated as follows (using the relevant IADC formula):

235 km + (1000•CR•A/M)
=235 km+1000+59.1/2155
=262.4 km

CR =Solar radiation pressure coefficient;
A =Average cross sectional area based on deployed on-station configuration;
Note: CR•A is a parameter derived from Orbital determination software ≈59.1 m^2:
M =Satellite dry mass≈2.155 kg (the satellite mass at de-orbit)

The amout of propellant needed to achieve the minimum deorbit altitude is based on the delta-V required and specified by the spacecraft manufacturer, the required mass of propellant fot the de-orbit operation will be reserved in the tank before the end of life. Propellant tracking is accomplished using a bookkeeping method. Any propellant in excess of the expected bookkeeping values will be consumend by further raising the orbit until consumption is no longer possible. Finally, all stored energy sources on board the satellite will be discharged by venting excess propellant, discharging batteries, relieving pressure vessels, and other appropriate measures. The table below provides futher information regarding the amount of helium (pressure, container and volume) from the THOR-7 propulsion system remaining at en-of-life:

THOR -7		
container		status on end of life
1	fuel	vent by leaving thruster valve open
2	oxidizer	vent by leaving thruster valve open
3	heilum	sealed: 50 litre, 6Mpa(<0.5kg),0-40°C
4	helium	sealed: 50 litre, 6Mpa(<0.5kg),0-40°C
5	helium	sealed: 50 litre, 6Mpa(<0.5kg),0-40°C

Kjell Aksberg
Director Operations
Telenor Satellite