Debris Reduction Investigation of GEO Satellite Through Its Whole Lifetime

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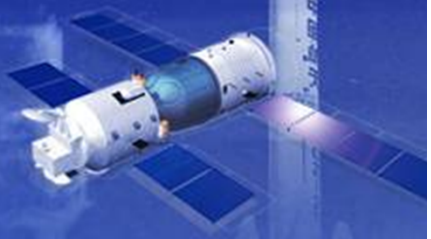

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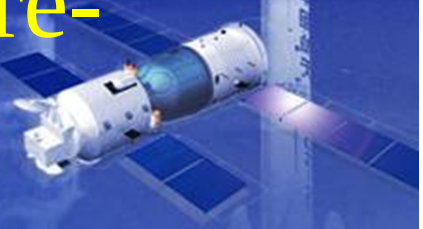
Introduction(1)

- Space debris comprises all non-functional, man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the Earth's atmosphere.



- The growing population of these objects poses an increasing hazard to space systems.

Introduction(2)

- In the article, debris reduction of GEO satellite through its whole lifetime is investigated, such as FY-4 satellite.
- The research can serves as reference for debris reduction of other GEO satellites through their whole lifetime.
- The experience of FY-4 debris reduction also provides a valuable experience for the standards on disposal of satellites which will be issued in the future.

Introduction(3)

- The whole lifetime of satellite should include design stage, launch stage, in-orbit stage, de-orbit stage.
- The debris reduction of GEO satellite also includes the four stage.

Design phases(1)

During the design of spacecraft or orbital stages, each program or project should demonstrate, using failure mode and effects analyses or an equivalent analysis, that there is no probable failure mode leading to accidental break-ups. If such failures cannot be excluded, the design or operational procedures should minimise the probability of their occurrence.

Design phases(2)

1. no leak can occur that could cause the mixture of hypergolic propellants, no freezing of vent lines can occur as this could hinder venting operations,
2. Prevent batteries from accidentally breaking up, Prevent propellant or fluids, such as pressurant, from causing an accidental break-up by designing a propulsion system so that make safe all remaining on-board sources of stored energy in a controlled sequence.

Design phases(3)

3. The determination of accidental break-up probability shall quantitatively consider all known failure modes for the release of stored energy, excluding those from external sources such as impacts with space objects and meteoroids.
4. Planning de-orbit strategy. Determine the schedule and amounts of action and drift rate.

Launch phases

Avoiding the release of fragments and ensuring that those objects do not jeopardize or constrain other space systems. If the release of mission-related objects into Earth orbit is unavoidable, then the mission-related objects shall remain outside the GEO protected region and limit their presence in the LEO protected region to a maximum of 25 years after their release.

In-orbit phases(1)

During the operational phases, the satellite should be periodically monitored to detect malfunctions that could lead to a break-up or loss of control function. In the case that a malfunction is detected, adequate recovery measures should be planned and conducted; otherwise disposal and passivation measures for the spacecraft or orbital stage should be planned and conducted.

In-orbit phases(2)

1. Reduce object abandoned when the satellite in its orbit phases.
2. Fault monitoring: Tank pressure and temperature should be monitored during the operation of the space system.
3. Prevent batteries from accidentally breaking up, e.g. as a result of pressure increase, by using structural or electrical means.
4. Avoidance of intentional destruction and other harmful activities.

Post-mission de-orbit operation phases(1)

Firstly, re-check satellite's condition before end-of-life disposal, determine initial orbit condition accurately and planning de-orbit strategy. Then operate the de-orbit practice.

All on-board sources of stored energy of GEO satellite, such as residual propellants, batteries, high-pressure vessels, self-destructive devices, flywheels and momentum wheels, should be depleted or safed. Minimise the potential for post mission break-ups resulting from these stored energy.

Post-mission de-orbit operation phases(2)

During disposal, terminate radio frequency communications.

Finally, make the orbit of the satellite has a perigee altitude sufficiently above the geostationary altitude that long-term perturbation forces do not cause the spacecraft to enter the GEO protected region within 100 years.

Conclusion(1)

In 1 September 2006 China implemented a de-orbit operation for FY-2B satellite.

Following this, in 5 November 2007 FY-2A satellite has also carried out a similar disposal.

They never again interferes the GEO protected regions during a long time.

The experiences of these two GEO post-mission disposals provides a valuable experience for the standards on disposal of satellites which will be issued in the future.

Conclusion(2)

In this article, debris reduction of GEO satellite through its whole lifetime is investigated, such as FY-4 satellite. The research can serves as reference for debris reduction of other GEO satellites through their whole lifetime. The experience of FY-4 debris reduction also provides a valuable experience for the standards on disposal of satellites which will be issued in the future.

Thanks !