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EUMETSAT REPORT ON ACTIVITIES ON SPACE DEBRIS/COLLISION MITIGATION MEASURES

This paper reports about the EUMETSAT activities on Space Debris mitigation and Collision Avoidance measures.

The paper, after giving some information about the EUMETSAT general activities on Space Debris mitigation, it also provides a more detailed report on the Meteosat-6 re-orbiting and on the 1st Collision Avoidance manoeuvre executed with Metop-A on1 May 2011.

EUMETSAT Report on Activities on Space Debris/Collision Mitigation Measures

1 INTRODUCTION

In the past years the need to preserve the outer space for future usage has been recognised worldwide. From the Inter-Agency Space Debris Coordination Committee – IADC:

"It has been a common understanding since the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) published its Technical Report on Space Debris in 1999, that man-made space debris today poses little risk to ordinary unmanned spacecraft in Earth orbit, but the population of debris is growing, and the probability of collisions that could lead to potential damage will consequently increase. It has, however, now become common practice to consider the collision risk with orbital debris in planning manned missions. So the implementation of some debris mitigation measures today is a prudent and necessary step towards preserving the space environment for future generations."

EUMETSAT was following the "IADC Space Debris Mitigation Guidelines" and reached full compliance with these for the End-of-Life operations of Meteosat-5 and Meteosat-6.

However, both due to the operations of Low Earth Orbit missions (e.g. Metop) and to the rapid evolution of the Space Debris documentation, EUMETSAT decided to establish a "Space Debris Working Group" (SDWG) to coordinate the EUMETSAT internal activities on this topic. The group was established in April 2011 with the following tasks:

- Establishment of the EUMETSAT Guidelines on Space Debris Mitigation;
- Establishment, coordination, and documentation of the operational aspects of End-of-life and Conjunction Warning/Collision Avoidance operations;
- Support the EUMETSAT Programmes for the coordination with external agencies on the Space Debris matters;
- Review of applicable standards and guidelines (e.g. IADC 'Space Debris Mitigation Guidelines', European Code of Conduct on Space Debris Mitigation, ISO 'Routes to Compliance and Management for Space Debris Mitigation' (now ISO 24113), EC 'Code of Conduct for Outer Space Activities' ...etc.).

The EUMETSAT SDWG includes EUMETSAT staff with expertise ranging from flight dynamics to satellite operations and legal matters. The group meets up to twice per year

to review the mitigation guidelines and to review the status of the in flight satellites with respect to the space debris guidelines.

The following paragraphs describe the current status of the SDWG tasks.

2 ACTIVITIES ON SPACE DEBRIS MITIGATION

2.1 EUMETSAT Guidelines on Space Debris Mitigation

These guidelines intend to establish the EUMETSAT policy for the space debris mitigation. They are largely inspired to the recently published "Space debris mitigation requirements", ISO Standard 24113 and they require an assessment of the EUMETSAT satellites against the ISO 24113 requirements. A distinction is made between the existing projects, for which the ISO 24113 is taken as a reference and the future projects, for which the ISO 24113 is proposed as applicable. The guidelines also define a "waiver process" and an "approval agent" for space debris matters.

A first version of the EUMETSAT Guidelines was drafted in July 2011 and it is currently under review inside the SDWG. Once the SDWG review is completed, the guidelines will be submitted to EUMETSAT senior management and, if approved, they will be released before end of 2011.

2.2 End-of-life and Conjunction Warning/Collision Avoidance operations

2.2.1 End-of-life operations

Both Meteosat-5 and Meteosat-6 satellites have been re-orbited by EUMETSAT in Aprl 2007 and April 2011 respectively.

For Meteosat-5 the "IADC Space Debris Mitigation Guidelines" were followed and full compliance to them achieved as far as end-of life operations was concerned (see section 2.3 of CGMS-35 EUM-WP-04).

For Meteosat-6 the "ISO standard 24113 was followed and full compliance to it achieved as far as end-of life operations was concerned (see paragraph below).

Meteosat-6 end-of life operations

Meteosat-6's re-orbiting was performed in accordance with the Space Debris regulations and in particular with the International Standards Organisation "Space Systems – Space Debris Mitigation" document ISO TC 20/SC 14 N 24113, 1 February 2010. The activities took place between 28 March 2011 and 2 May 2011. The following activities were performed:

- Pre-re-orbiting tests:

- Full Earth Imaging with redundant electronics;
- Full Earth Imaging with nominal electronics;
- Rapid Scans Imaging with nominal electronics;
- Redundant Detectors test;
- MPT Coaxial Switch Test;
- Fuel On-Board measurement Test;

- Re-orbiting Manoeuvres;

- Spacecraft payload and platform passivation operations;

- Final orbit determination.

After the end-of-life tests, which were designed primarily to check the status of the redundant units after so many years in orbit, the proper re-orbiting operations started on 11 April 2011 as planned. The Meteosat-6 re-orbiting operations were prepared by EUMETSAT using the sequences used in April 2007 for the Met-5 re-orbiting as a basis. The re-orbiting operations were reviewed by Thales Alenia Space and were provided for comments to ESOC and CNES. Regular teleconferences with Thales Alenia Space were organised throughout the most critical phases of the re-orbiting operations to get the necessary support and advice in case of unexpected behaviours.

In compliance with the space debris mitigation guidelines of the International Standards Organisation "Space Systems – Space Debris Mitigation" document ISO TC 20/SC 14 N 24113, 1 February 2010, the objective was to raise the orbit of Meteosat-6 to at least 250 km above the geostationary ring and, at the same time, to reduce the satellite spin rate. The reduction of spin rate minimises the risk that satellite debris re-enter the geostationary ring, should the satellite decompose itself in fragments in the long term.

For the re-orbiting operations a fuel budget of 3.9 kg was estimated, based on a "book keeping" method. Several manoeuvres were performed between 11 and 15 April 2011, followed by a venting of the fuel pipes and tanks to achieve a final orbit of approximately 350 km (perigee) x 384 km (apogee) above the geostationary ring with a final spin-rate of approximately 72 rpm (with the initial spin rate having been about 99.9 rpm). The actual fuel mass was found to be about 3.7 kg (i.e. about 200g difference between the estimated and actual mass).

The satellite switch-off was completed on 2 May 2011. The last command to Meteosat-6 was sent at 09:08UTC, marking the end of this satellite's operational life after more than 17 years in orbit operations.

All the Meteosat-6 re-orbiting operations were successful, the fuel budget was quite accurate and the ISO 24113 recommendations were fulfilled with good margins.

2.2.2 Conjunction Warning/Collision Avoidance operations

A "Conjunction Warning" service was requested by EUMETSAT via NOAA to the "Joint Space Operations Command" of the United States Air Force and is currently in place for all EUMETSAT in-flight satellites. This service provides both warning messages and regular screening messages to the operations teams whenever a piece of debris is close enough to one of the EUMETSAT operational satellites. Based on this information, the EUMETSAT operations teams can decide whether to perform a "Collision Avoidance" manoeuvre or not. In addition, the service allows to check, before each manoeuvre, if the planned manoeuvre brings the satellite any closer to a piece of debris.

Metop Collision Avoidance Manoeuvre on 1 May 2011

In late April 2011, the satellite collision warning process that EUMETSAT established with the US Air Force Joint Space Operations Command, identified a high risk debris conjunction event concerning METOP-A. After the analysis performed by the EUMETSAT Flight Dynamics team, it was decided that the manoeuvre will be performed, as the risk of collision was significantly higher than the acceptable threshold. The burn took place on 1 May 2011 at 03:28 UTC, according to the dedicated manual procedure for unplanned manoeuvres. As usual for an in-plane manoeuvre, this required an outage of both SEM & GOME (as they both had to be in safe modes before the firing), and a general degradation of all the other products during the manoeuvre mode. This is the first time that EUMETSAT has had to manoeuvre Metop-A due to collision risk.

3 CONCLUSIONS

This paper reports about the EUMETSAT activities on Space Debris mitigation and Collision Avoidance measures.

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