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English only

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**Committee on the Peaceful  
Uses of Outer Space**  
**Scientific and Technical Subcommittee**  
**Forty-ninth session**  
Vienna, 6-17 February 2012

**Note by the Secretariat**

1. In the report on its forty-eighth session, the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space made a recommendation, endorsed by the Committee on the Peaceful Uses of Outer Space at its fifty-fourth session (A/66/20), that Member States and space agencies should once again be invited to provide reports on research on space debris, the safety of space objects with nuclear power sources on board and problems relating to the collision of such space objects with space debris (A/AC.105/987, para. 89) as well as information on their activities and research in the field of Near Earth Objects (A/AC.105/987, annex III, para. 9).
2. The present document was prepared on the basis of reports received from the European Space Agency.
3. The replies contained in the present document were not formally edited.



## European Space Agency

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### European Space Agency's Space Debris Activities in 2011

In compliance with commitment of the European Space Agency (ESA) to space debris mitigation, the ERS-2 satellite was decommissioned on September 5, 2011 at 15:16 UTC. As part of this process, its orbit was initially lowered between July 6 and August 25 in a sequence of 7 manoeuvre blocks of 3 to 5 days duration each. The targeted orbit was close to 570 km, and hence about 210 km below the operational altitude at 780 km. This disposal altitude allowed a synchronous ground track pattern that allowed regular ground station contacts to perform a depletion of remnant propellants in 6 burns between August 26 and September 5. Further steps towards the spacecraft passivation were taken by disconnecting the batteries, and by switching off the communication on September 5, 2011 at 15:16 UTC. The final orbit and attitude after disposal was confirmed by measurements of the German TIRA radar (Tracking and Imaging Radar). From its 570 km near-circular orbit the satellite is expected to decay within about 15 years (well below the internationally adopted value of 25 years).

In the time span January to October, 2011, ESA satellites generated 79 warnings of close proximities with known objects of the United States Space Surveillance Catalogue. Five of these warnings emerged during the ERS-2 disposal phase. Three conjunction warnings led to evasive manoeuvres, because (1) on March 15, at 10:30 UTC, a Cosmos 2251 fragment would have passed ERS-2 at 840m, (2) on April 16, at 15:06 UTC, a Thor Ablestar fragment would have passed Envisat at 195m, and (3) on August 17, at 23:36 UTC, an uncorrelated object would have passed Envisat at 165m.

ESA launched its second Automated Transfer Vehicle (ATV-2 "Johannes Kepler") on February 16, 2011 at 21:50:55 UTC. It docked to the ISS on February 24, at 15:59 UTC, to provide fuel and supplies, totalling 7 tons of the spacecraft launch mass in excess of 20 tons. While it was docked, ATV-2 raised the orbit of the ISS on June 12 by 19 km, and between June 15 and 17 by another 15 km. ATV-2 also carried a Re-entry Break-up Recorder (REBR) to log measurement data on its destructive atmospheric re-entry, to improve the understanding of physical processes that lead to the break-up, and to calibrate mathematical break-up models. ESA also provided input to NOTAM and NAVAREA messages that were issued by nations under whose authority the ATV re-entry target area in the South Pacific lies. ATV-2 undocked from the ISS on June 20, and it re-entered in the designated South Pacific zone on June 21.

In the course of 2011 ESA's Space Debris Office, in conjunction with the ESA General Studies Programme, performed a systematic review and analysis of past, ongoing, and planned ESA missions with regard to their on-orbit and re-entry risk potential, and the respective compliance with related ESA requirements. For Sentinel-2 and MetOp-A more detailed re-entry risk assessments were performed to analyse their compliance status with respect to ESA guidelines.

In early 2011, the ESA space debris environment model MASTER-2009 (Meteoroid and Space Debris Terrestrial Environment Reference) was distributed to the scientific and engineering community. This updated model reflects major changes in the recent debris environment due to the FengYun-1C ASAT test in 2007, and due to the Cosmos-2251/Iridium-33 collision in 2009. MASTER-2009 was also re-designed to enable dynamic population updates, with possible overlays of fragmentation clouds, to allow a faster response to a rapidly changing environment.

As a member of the Inter-Agency Space Debris Coordination Committee (IADC), and as host of the IADC re-entry events database, ESA took part in two re-entry prediction test campaigns in 2011. The first one dealt with the US satellite UARS that re-entered on September 24, at 04:00 UTC, and the second one focused on the German ROSAT, with a re-entry one month later. These IADC campaigns are meant to test and improve the data exchange and prediction capabilities in the case of high-risk entry events (which was not the case for UARS and ROSAT).

To improve European awareness of the space situation, ESA has established a Space Situation Awareness Preparatory Programme (SSA-PP). As part of the SSA-PP, user requirements and system requirements on space surveillance and tracking were developed. As a proof-of concept also prototype surveillance radar breadboards and precursor applications were procured.

In the standardization area ESA further contributed to the development of ISO standards on space debris mitigation. In the context of CCSDS (Consultative Committee for Space Data Systems) ESA also took part in the development of standardized formats for the exchange of conjunction data messages (CDM) that will contribute to safer space operations in the future.

### **Safety of Space Objects with Nuclear Power Sources on Board — Activities 2011**

In 2011, ESA did not launch or conduct any space mission involving the use of nuclear power sources. Following the active participation of ESA in the development of the “Safety Framework for Nuclear Power Source Applications in Outer Space” jointly prepared by the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space and the International Atomic Energy Agency, ESA is currently investigating the most suitable options for adapting the framework and implementing the guidance it provides with the objective to protect people and the environment in Earth’s biosphere from potential hazards associated with relevant launch, operation and end-of-service phases of space nuclear power source applications.

#### **1. Introduction**

Near-Earth objects (NEOs) pose a potential global threat. Impacts of large objects on the Earth have had catastrophic consequences in the past. Smaller objects with consequences at regional or local level reach the Earth regularly.

Since many years, ESA has been supporting industrial and academic research in the field of NEOs, in the context of the ESA General Studies Programme in close cooperation with the Space Science Programme and the Technical and Quality Management Directorate; since 2008 the Space Situational Awareness (SSA) programme has started to contribute in the context of building up a “SSA near-Earth

object segment (SSA-NEO)". Altogether, the goal of ESA is to push forward our knowledge about asteroids and mitigate the risk of an asteroid impact on the Earth.

## 2. The SSA-NEO segment

The objective of the Space Situational Awareness (SSA) system is to support the European independent utilisation of and access to space for research or services, through providing timely and quality data, information, services and knowledge regarding the environment, the threats, and the sustainable exploitation of the outer space.

The SSA-NEO segment shall, according to its designed objectives, perform the following activities:

- (a) Tracking of all NEOs above a given size or risk threshold;
- (b) Determination of the orbit state, physical parameters (e.g. albedo, size, mass, rotation period, mineralogical composition) and of associated uncertainties (co-variances) and provide a single place of information for these and spacecraft data;
- (c) Provide orbit determination and prediction data of tracked NEOs in state or ephemeris format with known accuracy;
- (d) Maintenance of available orbit data and physical characteristics of all known NEOs;
- (e) Identification and ranking of NEO collision risks with the Earth, provide warnings;
- (f) Provide related tools.

The SSA-NEO segment follows two paths — a top-down design for a European asteroid warning system, integrated into the ongoing international efforts; and a bottom-up development of so-called "precursor services" where existing systems are federated and put on proper funding. The top-down design efforts are ongoing and producing a set of requirements documentation, which can be used to set up the final operational system. The precursor system is starting to take shape and is presented below in more detail.

## 3. Observations

As part of the SSA-NEO segment activities, ESA has been using its 1-m telescope on Tenerife (the Optical Ground Station, OGS) regularly for observing asteroids. The main goal was to use the telescope for testing procedures and software for asteroid observations. In the course of these tests, follow-up observations of objects on the NEO Confirmation Page of the Minor Planet Center and the Spaceguard Central Node's priority list have been performed. In addition, a small survey was started to gain experience with these kinds of operations, called TOTAS (Teide Observatory Tenerife Asteroid Survey). Including a precursor phase of one week in Sep 2009, TOTAS has discovered over 300 asteroids. At the end of September 2011 it discovered its first near-Earth object (asteroid 2011 SG208). More than 30000 astrometric measurements have been performed in on average two clear nights per month.

#### **4. SSA-NEO precursor service**

In 2010, ESA has started a contract to set up a so-called precursor service for its SSA-NEO service. Within this contract, a web presence will be implemented that will federate the existing NEODyS service of the University of Pisa/Italy and Valladolid/Spain and the priority list of the Spaceguard Central Node (SCN). A database for NEOs has been implemented which will be maintained by the operators of the EARN (European Asteroid Research Node) database at DLR Berlin in Germany. Service-Level Agreements have been put in place with the operators. At the time of writing, the service is being implemented on a test environment. The federated environment is expected to be exposed to external users beginning of 2012. It will provide supportive funding to NEODyS, SCN priority list and EARN at least until the end of the SSA Preparatory Programme (end of 2012).

#### **5. Preparation of a SSA-NEO system**

In 2010 ESA's General Support Technology Programme funded a study called "Enabling technologies for SSA, NEO segment". It was completed in February 2011 and produced requirements and a first functional breakdown for a European NEO system. This study was used as a starting point for a more general study on SSA level.

As part of a study for a European SSA system, requirements for a European SSA-NEO segment have been defined. The produced documentation is undergoing an external review. Funding is in place to start an architectural design study for the complete SSA system including the NEO segment at the end of 2011. It is foreseen that two competing industrial studies are performed. The actual implementation of the SSA system will have to be approved at the next ESA Council meeting on ministerial level in fall 2012.

#### **6. Support of Action team 14**

Since 2003, ESA has been supporting the activities of the Action Team 14, which under the mandate of the United Nations Committee on the Peaceful Uses of Outer Space prepares a strategy for dealing with the asteroid impact threat. Several meetings of the Action Team 14 were supported by ESA experts. In particular, ESA has hosted the first workshop to prepare the Mission Planning and Operations Group (MPOG) in October 2010 at its European Space Operations Centre in Darmstadt, Germany. The workshop was the first step in defining the detailed tasks and responsibilities of the MPOG.

#### **7. Mission-related studies**

ESA is currently studying an asteroid sample return mission which would go to asteroid 1996 FG3, a binary asteroid. This study was selected as one of four competing science mission studies for the "M3" launch slot of ESA's Cosmic Vision programme. The aim of MarcoPolo-R is to fly to the asteroid, take a sample, and return the sample to Earth for ground-based lab analysis. Additional in situ science will be performed to put the sample in context. At the time of writing this report, ESA is performing an internal mission design in its Concurrent Design Facility. In 2012, at least two parallel industrial studies will be performed to define the mission scenario and the spacecraft with payload in detail. In the beginning

of 2013, ESA's advisory structure will select two out of the four competing missions for further detailed study, with a selection of one mission for implementation in 2014. This study is funded by ESA's General Study Programme.

The Near-Earth Exploration Minimum System (NEMS) internal ESA study was conducted at ESA's Concurrent Design Facility (CDF) between March and April 2011. Its aim was to investigate and report on the main trade-offs, system drivers and critical risk areas associated with even the most basic human exploration beyond Earth-Moon system. The mission scenario addressed the transfer a crew of 3 astronauts from the Earth to an accessible near-Earth asteroid and their safe return to Earth before 2030. The study was funded by the ESA General Studies Programme and has been used to identify auxiliary studies in areas where technical and scientific progress can be made to address uncertainties, risks and knowledge gaps, regardless of the specific exploration targets and mission scenarios ultimately being considered. By addressing the transfer to a near-Earth asteroid target it also served to complement previous studies on other potential exploration destinations (Moon, Mars).

#### **8. Other relevant items**

ESA's comet mission Rosetta has flown by the asteroid Lutetia on 10 July 2010 and returned spectacular images from this 110 km size object. A large team of scientists has access to the data and is currently analysing it. The first publications in scientific literature have shown that the asteroid has 16-19 per cent albedo at 550 nm and shows a large variety of craters in all sizes. Boulders and landslides can be seen in the images. Some of the returned data indicates that the object is a differentiated body.

From 2010 to February 2011, ESA's General Studies Programme has funded a study called "asteroid ephemerides". Two parallel studies were performed by Deimos (Spain) and the Institute de Mechanique Celeste e de Calcul des Ephemerides (IMCCE, France). The scope of the study was to evaluate the state of the art of asteroid ephemerides prediction. On the basis of this analysis a roadmap was defined to identify improvements required to the ephemerides models and the type of measurements. This work allows to better assess how the knowledge of asteroid orbits can be improved and directly supports to SSA-NEO programme.

ESA has put funding in place and is getting ready to kick off a number of additional related studies: the development of a pair of robotic telescopes for the automated observation of both asteroids and space debris; the design and development of a Visible-Infrared camera and polarimeter for asteroid characterisation; the update of an asteroid population model, and a study about impact effects and mitigation.