

## **Guidelines for De-commissioning of Satellite and Mitigation of Space Debris**

### **Introduction**

Some of the existing satellites of Hong Kong may have reached the end of their designed life of operation or have retired from service. There is a need for these satellites to be de-commissioned in order to vacate the orbit for new or replacement satellites. Moreover, the population of man-made space debris is growing and the probability of collisions which could lead to potential damage to operational satellites will consequently increase. The implementation of debris mitigation measures today is a prudent step towards preserving the space environment for future generations.

2. The Outer Space Ordinance (Chapter 523) (“Ordinance”) confers licensing and other powers on the Chief Executive to secure compliance with the international obligations of the People's Republic of China with respect to the launching and operation of space objects and the carrying on of other activities in outer space.

3. The Chief Executive has authorized the Telecommunications Authority (the “Authority”) to administer the Ordinance.

4. Pursuant to the relevant conditions of the licences issued under the Ordinance<sup>1</sup>, the licensee shall conduct the licensed activities in a proper and business-like manner, in compliance with the laws of the Hong Kong and in conformity with the obligations of the People’s Republic of China under international law, and in particular the licensee shall not:-

- so conduct its operation as to create any risk of contamination of outer space or adverse changes in the environment of the earth or jeopardise public health or the safety of persons or property in any part of the world;
- interfere with the activities of others in the peaceful exploration and use of outer space;
- cause or in any way be party to any actions or defaults which may give rise to liabilities on the part of the People’s Republic of China or the HKSARG under international law;

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<sup>1</sup> Formerly issued under the Outer Space Act 1986 (Hong Kong) Order 1990 before the enactment of the Ordinance in July 1997.

- prejudice in any way the national security of the People’s Republic of China or the security of the HKSARG; or
- terminate any activity to which the licence relates or cease to control the operation of the satellite without the prior consent in writing of the Chief Executive.

5. Without prejudice to the generality of the Ordinance and power exercisable by the Chief Executive under the Ordinance, this document (“the Guidelines”) is issued by the Authority for the purpose of providing practical guidance to the licensees on the requirements of decommissioning of existing satellites and limiting the generation of space debris in the environment. The licensees shall observe the Guidelines and the relevant requirements of the licence conditions or other requirements as appropriate.

### **Adoption of the IADC Space Debris Mitigation Guidelines**

6. The [IADC<sup>2</sup> Space Debris Mitigation Guidelines](#) (“the IADC Guidelines”) are the internationally developed consensus relating to the mitigation of orbital debris, post-mission disposal of space objects and prevention of on-orbit collisions. They are recognized as the international best practice for mitigating space debris. After consultation with the satellite industry, the Authority adopts the IADC Guidelines for implementation. As the Guidelines are developed on the basis of the IADC Guidelines, reference should be made to the relevant parts of the IADC Guidelines in the implementation of the measures.

7. Furthermore, operators are recommended to refer to a supplementary IADC document entitled ["Support to the IADC Space Debris Mitigation Guidelines"](#) (“the Support to the IADC Guidelines”) for further useful and detailed information. The ITU-R Recommendation S.1003-1 entitled “Environmental protection of the geostationary-satellite orbit” is also a useful reference which makes recommendations similar to that of the IADC Guidelines and provides detailed description on the formula being adopted in the IADC Guidelines for calculating the minimum re-orbit altitude at the end-of-life disposal.

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<sup>2</sup> IADC stands for Inter-Agency Space Debris Coordination Committee, which is an international forum of governmental bodies for the coordination of activities related to the issues of man-made and natural debris in space. The primary purpose of the IADC is to exchange information on space debris research activities between member space agencies to facilitate opportunities for co-operation in space debris research, to review the progress of on-going co-operative activities and to identify debris mitigation options. Refers to <http://www.iadc-online.org/> for full details of IADC and its members.

8. The IADC Guidelines cover the overall environmental impact with a focus on the following:

- (1) limitation of debris released during normal operations;
- (2) minimization of the potential for on-orbit break-ups;
- (3) post-mission disposal of space objects; and
- (4) prevention of on-orbit collisions.

9. For illustrative purposes, relevant salient points from the IADC Guidelines are extracted below :

(1) Limitation of debris released during normal operations (paragraph 5.1)

Space systems should be designed not to release debris during normal operations or any release of debris should be minimised in number, area and orbital lifetime. Furthermore, any programme, project or experiment that will release objects in orbit should not be planned unless an adequate assessment can verify that the effect on the orbital environment, and the hazard to other operating space systems, is acceptably low in the long-term.

(2) Minimization of the potential for on-orbit break-ups (paragraph 5.2)

On-orbit break-ups caused by the following factors should be prevented:

- (1) The potential for break-ups during mission should be minimised
- (2) All space systems should be designed and operated so as to prevent accidental explosions and ruptures at end-of-mission
- (3) Intentional destructions, which will generate long-lived orbital debris, should not be planned or conducted.

To avoid accidental break-ups of de-commissioned satellites which would produce large amount of space debris, passivation measures like venting residual propellant/ high pressure vessels, discharging batteries, disabling self-destructive devices should be taken to minimise the potential of post-mission break-ups resulting from stored energy.

During the design of a space system, each programme or project should demonstrate that there is no probable failure mode leading to accidental

break-ups or the design or operational procedures should minimise the probability of their occurrence. Moreover, during the operational phases, a space system 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, or otherwise disposal and passivation measures for the system should be planned and conducted.

### (3) Post-mission disposal (paragraph 5.3)

Specifically, to prevent de-commissioned GSO satellites from drifting back to altitudes at which active GSO satellites operate due to gravitational forces and solar radiation forces, the minimum increase in perigee altitude at the end-of-life manoeuvre, taking into account the orbital perturbations, is :-

$$235 + (1000 \cdot C_R \cdot A/m) \text{ [km]}$$

where  $C_R$  = solar radiation pressure coefficient (typical values between 1 and 2)

$A/m$  = aspect area to dry mass ratio of satellite [ $\text{m}^2/\text{kg}$ ]

### (4) Prevention of on-orbit collisions (paragraph 5.4)

In developing the design and mission profile of a space system, a program or project should estimate and limit the probability of accidental collision with known objects during the system's orbital lifetime.

## **Retirement of existing on-orbit satellites**

10. Should the licensee intend to retire an existing on-orbit satellite which was launched before 31 July 2007, it has to submit a detailed disposal plan to the Authority for approval as soon as possible before the disposal operation commences. The licensee shall comply with this requirement unless justification for non-compliance is provided to the satisfaction of the Authority.

11. Among the details that are to be provided in the disposal plan, the altitude of disposal orbit as recommended by the satellite manufacturer must be clearly specified and should conform to that recommended in 9(3) above as far as possible. The relevant technical information such as the quantity of fuel that will be reserved for the disposal manoeuvre and the calculations that are required to determine the disposal altitude shall also be provided in the plan for consideration by the Authority.

12. Furthermore, the licensee is required to incorporate into the disposal plan the measures as recommended in paragraph 9(2) above for minimizing the potential of post-mission break-ups resulting from stored energy.

13. Upon approval by the Authority, the licensee shall proceed to re-orbit the satellite according to the approved disposal plan. Upon completion of the end-of-life manoeuvre, the licensee has to formally inform the Authority of the actual disposal altitude of the decommissioned satellite. If the satellite fails to reach the disposal orbit as that planned, the licensee shall provide explanation to the satisfaction of the Authority.

14. Licensee should note that, pursuant to Clause 2.1.1 of the schedule to the outer space licence, the termination of an outer space licence shall not take effect until the Chief Executive is satisfied that the licensed activities have been terminated and the satellite disposed of or otherwise dealt with to the satisfaction of the Chief Executive.

### **New Applications for Outer Space Licence**

15. As from 31 July 2007, when an entity wants to apply for an outer space licence, it has to provide a mitigation plan together with the submission of application. The mitigation plan will need to be scrutinised and approved by the Authority before an outer space licence is granted.

16. The scope to be covered by a mitigation plan is wider than that covered by a disposal plan. Reference should be made to Item 5 of the Support to the IADC Guidelines. It should be noted that the mitigation plan should include the following:

- a management plan addressing space debris mitigation activities;
- a plan for the assessment and mitigation of risks related to space debris, including applicable standards;
- the measures minimising the hazard related to malfunctions that have a potential for generating space debris;
- a plan for disposal of the space system at end of mission;
- justification of choice and selection when several possibilities exist; and
- compliance matrix addressing the recommendations of the IADC Guidelines;

17. After obtaining the licence, the licensee should be responsible for the implementation of the mitigation plan and to report any non-compliance with the plan to the Authority. In case any non-compliance is found during the design, manufacture, operation and disposal of the satellite, the Authority may request the licensee to take all reasonable courses of actions to re-align with the approved mitigation plan. The licensee shall comply with such request unless justification for non-compliance is provided to the satisfaction of the Authority.

### **Changes to the Guidelines**

18. In consultation with the industry, the Guidelines may from time to time be amended, as and when it is considered necessary, and subject to review in the light of experience in applying it over time and the relevant amendments in the IADC Guidelines.

Office of the Telecommunications Authority  
31 July 2007