ATTACHMENT 1

TECHNICAL APPENDIX

ORBITAL DEBRIS INFORMATION MATRIX

Satellite Name	Orbital Debris Information Provided?	Notes
GE-23	No	U.S. Licensed
Superbird C2	Yes	
Asiasat 5	Yes	
Yamal 201	Yes	
Eutelsat 10A (W2A)	Yes	
Anik F1	Yes	
Estrela do Sul 2 (T-14R)	No	Added to Permitted List on April 4, 2011
Intelsat 14 (IS-14)	No	U.S. Licensed
Telstar 11N	No	U.S. Licensed
Apstar 6	Yes	
Apstar 7	Yes	

SKY Perfect JSAT Corporation

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SUPERBIRD-C2 Satellite
End of Life Disposal and Debris Mitigation Plan

This statement is prepared by SKY Perfect JSAT Corporation ("JSAT") for the purpose of demonstrating the end of life disposal and debris mitigation policies associated with the SUPERBIRD-C2 telecommunications satellite.

Introduction:

The SUPERBIRD-C2 satellite operated by JSAT was manufactured and supplied by Mitsubishi Electric Corporation and based on DS2000 bus platform. It was launched on August 15, 2008 with the designed life to be 15 years after In-Orbit Acceptance Review of the satellite.

SUPERBIRD-C2 is 3-axis stabilized and uses bi-propellant chemical propulsion for attitude and on-station control. The satellite is located at orbital slots 144° E.L. The TTC operation of SUPERBIRD-C2 satellite is performed by JSAT Satellite Control Center on basis 7x24 through the ground station located in Yokohama, Japan. For station keeping, the satellite is maintained within a box of size of ±0.05 degree.

Disposal plan and debris mitigation measures:

As a licensed operator in Japan, JSAT will strictly comply with the requirements as stipulated by the guidelines issued by IADC and United Nations and adhere to prevailing international best practices and standards to reduce space debris.

According to the said Guidelines, any expired satellite, which has to be de-orbited to the outer space, shall be disposed to an orbit with a delta- perigee (⊿a) higher than geo-synchronous orbit of no less than : 235Km + (1000 • CR • A/m)
Where CR is the solar pressure radiation coefficient of the spacecraft, and A/m is the Area to mass ratio, is square meters per kilogram, of the spacecraft.

JSAT will take into account this requirement for any de-orbit operation of this satellite and will reserve sufficient propellant in order to conform to the regulation set forth in Guidelines and comply with the following:

	⊿a requirement	Propellant needed
SUPERBIRD-C2	300Km	10.2kg

When JSAT applied for the Space station Carrier License from Japanese Ministry of

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Internal Affairs and Communications (MIC) for SUPERBIRD-C2, JSAT incorporated a disposal plan as well as debris mitigation measures. The license for SUPERBIRD-C2 was subsequently issued by MIC to JSAT for the launch and operation of the satellite.

The SUPERBIRD-C2 satellite is based on Mitsubishi DS2000 platform, which is widely known to be a mature and reliable satellite platform. In the design phase, the satellite manufacturer, Mitsubishi Electric Corporation in Japan has already considered this potential issue and design the satellite in such a way that industrial practices and standards are observed. There is no probable failure mode that would lead to accidental break-up and cause space debris. We therefore believe that the design of the satellite and the disposal measures in place are in line with IADC's Space Debris Mitigation Guidelines.

As the satellite is de-orbited, in accordance with to orbital raising operations, JSAT will configure the satellite with residual energy into a passive state. JSAT will implement procedures to minimize the on-board energy in whatever form of electrical, chemical, kinetic etc., which is considered as a potential source of generating harmful debris. These measures include shutting down the power generating subsystems and all power consumed components. Further, momentum wheels will be maintained at the lowest kinetic energy level. Pyrotechnic components would have been exhausted or completely disabled during operations in the initial stage of life. As such, we consider the risk of de-commissioning of the satellite will be kept minimal and conformed to the standard of the industry.

Annexes

1. IADC Space Debris Mitigation Plan, by Inter-Agency Space Debris Coordination Committee, September 2007
2. Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space by United Nations Office for Outer Space Affairs, 2010

- End -

SKY Perfect JSAT Corporation

Shigetaka Shinozuka
General Manager
Satellite Operation Division
December 28, 2012

AsiaSat 5 Satellite
End of Life Disposal and Debris Mitigation Plan

This statement is prepared by Asia Satellite Telecommunications Company Limited ("AsiaSat") for the purpose of assisting its customers who may be subject to the approval authority by such entities as the ITU, FCC USA or OFCA HK with regard to meeting the requirements in relation to the end of life disposal and debris mitigation of a telecommunication satellite.

Introduction:

The AsiaSat 5 satellite is manufactured and supplied by Space Systems/Loral in the United States and is based on the LS-1300 series satellite platform. The AsiaSat 5 satellite was launched on August 12, 2009 with a nominal propellant lifetime to meet the satellite's designed life of 15 years after the handover of the satellite from Space Systems/Loral.

AsiaSat 5 is a 3-axis stabilized satellite that uses bi-propellant chemical propulsion for station-keeping and attitude controls. The satellite is located at the nominal orbital location of 100.5E and station kept within a box of ±0.05 deg . The TTC operation of the satellite is performed by AsiaSat on a basis of 7×24 through the ground station located in Hong Kong.

Disposal plan and debris mitigation measures:

As a licensed satellite operator in Hong Kong, AsiaSat complies to the requirements as stipulated by the "Guidelines for De-commissioning of Satellite" (the "Guidelines") issued by OFCA (Hong Kong Office of Communications Authority) and adhere to prevailing international best practices and standards to reduce space debris.

According to the said Guidelines, any expired satellite, which has to be de-orbited to outer space, shall be disposed to an orbit with a delta-perigee (Δa) higher than geo-synchronous orbit of no less than:

$$235 \text{ km} + (1000 \cdot CR \cdot A/m)$$

where CR is the solar pressure radiation coefficient of the spacecraft, and A/m is the Area to mass ratio, in square meters per kilogram, of the spacecraft.

AsiaSat will take into account this requirement for any de-orbit operation of the AsiaSat 5 satellite and will reserve sufficient propellant in order to conform to the regulations set forth in the Guidelines:

	Δa requirement	Propellant needed
AsiaSat 5	280km	7.3 kg

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Website: http://www.asiasat.com

The respective disposal plan as well as debris mitigation measures constitute part of AsiaSat's submissions to OFCA for the application of the Outer Space Ordinance License and Space Station Carrier License.

The AsiaSat 5 satellite is based on the Space Systems/Loral Series LS-1300 series satellite platform, which is widely known to be a mature product and one of the most reliable satellite platforms. In the design phase, the satellite manufacturer, Space Systems/Loral already considered this potential issue and designed the satellite in such a way that industrial practices and standards are considered. There is no probable failure mode leading to accidental break-ups and causing space debris. The satellite manufacturer has established a dedicated SPACE DEBRIS MITIGATION PLAN. We therefore believe that the design of the satellite as well as disposal measures are in line with the regulations set forth in either IADC's Space Debris Mitigation Guidelines or Guidelines for De-commissioning of Satellite: issued by HK OFCA, 31 July 2007.

In addition to the orbit raising operation when de-orbiting AsiaSat 5, AsiaSat will configure the satellite with residual energy in a passive state. AsiaSat will implement procedures to minimize the on-board energy in whatever form of electrical, chemical, kinetic etc, which is considered as a potential source of generating harmful debris. These measures include shutting down the power generation subsystem and all active units. Further, momentum wheels will be maintained at the lowest kinetic energy level. The propellant and pressurized tanks will be eventually depleted and vented. Pyrotechnic components will have been used or disabled during operations in the initial stage of life. As such, AsiaSat considers the risk from de-commissioning of the satellite will be kept to a minimum and will conform to the standard of the industry.

Annexes:
Guidelines for De-commissioning of Satellite: issued by HK OFCA, 31 July 2007;
IADC Space Debris Mitigation Guidelines Revision 1: issued by IADC, Sep 2007;

Asia Satellite Telecommunications Company Limited

Roger Tong
VP Engineering and Operations

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GAZKOM OPEN JOINT STOCK COMPANY

APPROVED BY
First Deputy General
Director
(signature) Verkhoturov V. I.
on 24.03.2005

Yamal_KA extraterrestrial complex with Yamal-200 KA

Methods of reduction of GSO pollution

10AOGK.0000-0 PM-3

Director of the Department
of Space Projects
(signature) O. S. Grafodatskiy
21.03.05

Director of the Design Department
(signature) V. I. Kravchenko
21.03.05

Inv. #	Signature and date	Vzam. Inv. #	Inv. # doubl.	Signature and date

2005

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Design		Sharapov	(signature)	12.03.05	
Prov.		Kravchenko	(signature)	18.03.05	
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Approved		Kravchenko	(signature)	18.03.05	

Extraterrestrial complex Yamal-KA with KA Yamal-200
Methods of reduction of GSO pollution

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INTRODUCTION

This document was drawn up in order to secure fulfillment of the branch standard of the Federal Space Agency of the Russian Federation (OST 134-1023-2000); it is a common method of reduction of GSO pollution. This plan is used by Gazkom Open Joint Stock Company as one of the basic documents on reduction of space pollution in relation to KA Yamal-200.

1. REFERENCE DOCUMENTATION

The following documentation is not a formal part of this document; it is meant only for a more precise understanding of the contents:

1. Branch standard of the Federal Space Agency of the Russian Federation OST 134-1023-2000 "General Requirements on Reduction of the Man-caused NESE pollution".
2. Spacecraft Yamal-200 KA-1. Explanatory note. Part 12. Ballistics materials. 300GK.0000A201-0 PZ11 part 12.
3. Instruction on preparation of the initial data for flight control. Part 1. 300GK.0000A201-0 IE62 part 1.
4. Committee on the Peaceful Uses of Outer Space. Scientific and Technical Subcommittee Fortieth session. Vienna, 17-28 February 2003 Item 10 of the provisional agenda. Space debris.
5. IADS Space Debris Mitigation Guidelines. IADS-02-01. 15 Okt. 2002.

2. GENERAL INFORMATION ON KA YAMAL-200.

KA Yamal-200 was produced in compliance with the Russian standards and specifications, and has a connected useful load produced by Gazkom Open Joint Stock Company. The spacecraft is equipped with orientation engines and plasma correction engines running on xenon. KA Yamal-200 was launched in the year 2003, and the period of active existence will expire not earlier than in 2013.

3. EXPLOITATION OF KA YAMAL-200

All materials used in KA Yamal-200 pursuant to GOST R50109-92 have minimal coefficients of outgassing and loss of mass.

Exploitation of KA Yamal-200 at GSO, transfer of the SC to a different operating point at GSO (if necessary), deorbiting of SC [spacecraft] from GSO after regular exploitation should be carried out under permanent control of the ballistic group of the TH of the LBCC in order to secure flight safety and exclude collision with other SCs at the orbit.

On-board equipment of KA Yamal-200 includes equipment operating under pressure: NHAB, xenon SSB. There is no possibility of destruction of this equipment, and this is assured by a significant safety margin and confirmed by numerous ground tests and flight qualification, over 20 missions.

In the course of exploitation of the SC on the GSO and deorbiting of the SC any separations of structural components and devices from KA Yamal-200 are excluded.

KA Yamal-200 are functioning on the geostationary orbit in the orbital positions longitude 90 East and 49 East, pursuant to the application filed to the ITU and in compliance with all ITU legal regulations; therefore, possibility of collision with other SCs through the fault of Gazkom Open Joint Stock Company is excluded.

KA Yamal-200 is being operated in continuous mode. Correction of the orbit is carried out by a standard method in compliance with the plan for orbit correction.

Construction of on-board systems and principles of operation of KA Yamal-200 are arranged in such a way that no single failure or a single erroneous instruction lead to an unsanctioned ignition of the engines.

4. DEORBITING OF SC YAMAL-200

Gazkom Open Joint Stock Company has planned the following operations on deorbiting of the SC upon expiry of the period of active existence:

1. Calculation of the working medium reserve necessary for deorbiting of the SC from GSO upon completion of exploitation.

2. Telemetric control over working medium reserve of CEI (xenon) throughout the whole period of exploitation (requirement established by paragraph 4. 17.4.3 of TZ for KA Yamal-200).

3. Deorbiting of the SC from GSO upon completion of exploitation with respective working medium reserves of CEI (requirement established by paragraph 4. 17.4.3 of TZ for KA Yamal-200). Perigee of the orbit of SC taken to the deorbiting area should be not less than 200 km over the radius of geostationary orbit (OST 134-1023-2000). Considering this data, raise of altitude during deorbiting from GSO equal to 200 km is approved for KA Yamal-200 (300GK.0000A201-0 P311 part 12).

4. As part of measures aimed at passivation of the SC upon its withdrawal it is provided that all power sources will switched off, and thus transformation of the energy of the on-board power sources into destructive one is excluded. Such measures comprise:

- Transfer of the correction and orientation engines to the state of inoperability (shutdown of power sources). We would like to note that insignificant remnants of the engine installation's working medium (neutral xenon gas) are explosion-safe.

- Final discharge of the accumulator batteries upon instruction from the LBCC after deorbiting from GSO;

- Shutdown of the on-board equipment.

5. During deorbiting of the SC from GSO work of OOW radio line will be planned basing on exclusion of radio frequency interferences for other SCs.

5. NOTIFICATIONS.

Gazkom Open Joint Stock Company undertakes to provide copies of the documents related to this matter as required by (PKA, IADS) with all respective notifications, as provided by the law or regulations for spacecrafts of Gazkom Open Joint Stock Company, including, but not limited to matters of putting into operation, orbital position, moving to another point, alteration of the orbit incline, moving to another orbit.

SSB – xenon storage and supply block;
GSO – geostationary orbit;
SC – spacecraft;
ITU – International Telecommunications Union;
NHAB – nickel hydrogen accumulator battery;
LBCC – land based control center;
CEI – combined engine installation;
NESE – near-Earth space environment;
OOW – order operation wire;
TH – tracking headquarters.

ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО «ГАЗКОМ»

УТВЕРЖДАЮ
Первый заместитель
генерального директора
_____Верхотуров В.И.
«24» 05 2005 года

Космический комплекс «Ямал-КА» с КА «Ямал-200»

Методика сокращения загрязнения ГСО

10АОГК.0000-0 ПМ-3

Руководитель дирекции
космических проектов
_____О.С.Графодатский
21.05.05

Начальник
проектно-конструкторского отдела
_____В.И. Кравченко
21.05.05

2005

Инв.№ подл.	Подпись и дата	Взам. инв.№	Инв.№ дубл.	Подпись и дата

СОДЕРЖАНИЕ

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Справ. №
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Инв. № подл.

Изм.	Лист	№ докум.	Подп.	Дата
Разраб.		Шарапов		12.05
Пров.		Кравченко		18.3.05
Н.контр.				
Утв.		Кравченко		18.3.05

10АОГК.0000-0 ПМ-3

Космический комплекс «Ямал-КА»
с КА «Ямал-200»
Методика сокращения загрязнения ГСО

Лит.	Лист	Листов
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ВВЕДЕНИЕ

Настоящий документ создан в обеспечение выполнения отраслевого стандарта федерального космического агентства РФ (ОСТ 134-1023-2000) и представляет собой общую методику сокращения загрязнения ГСО. Данный план используется ОАО «Газком» как один из основополагающих документов по сокращению загрязнения космического пространства в отношении КА «Ямал-200».

1 ССЫЛОЧНАЯ ДОКУМЕНТАЦИЯ

Следующая документация является не формальной частью этого документа и предназначена для более четкого понимания содержания:

1. Отраслевой стандарт федерального космического агентства РФ ОСТ 134-1023-2000 «Общие требования по ограничению техногенного засорения ОКП».
2. Космический аппарат «Ямал-200» КА-1 Пояснительная записка Часть 12. Материалы по баллистике. 300ГК.0000А201-0 ПЗ11 ч.12.
3. Инструкция по подготовке исходных данных для управления в полете Часть1. 300ГК.0000А201-0 ИЭ62 ч.1.
4. Committee on the Peaceful Uses of Outer Space. Scientific and Technical Subcommitee Fortieth session. Vienna, 17-28 February 2003 Item 10 of the provisional agenda. Space debris.
5. IADS Space Debris Mitigation Guidelines. IADS –02-01. 15 Okt. 2002.

2 ОБЩИЕ СВЕДЕНИЯ О КА «ЯМАЛ-200»

КА «Ямал-200» изготовлен в соответствии с российскими стандартами и спецификациями, и имеет связную полезную нагрузку изготовленную ОАО «Газком».

Космический аппарат имеет двигатели ориентации и плазменные двигатели коррекции работающие на ксеноне.

КА «Ямал-200» запущен в 2003г., срок активного существования заканчивается не ранее 2013г.

3 ЭКСПЛУАТАЦИЯ КА «ЯМАЛ-200»

Все материалы используемые на КА «Ямал-200» в соответствии с ГОСТ Р50109-92 имеют минимальные коэффициенты массопотери и гажения.

Эксплуатация КА «Ямал-200» на ГСО, перевод КА в новую рабочую точку на ГСО (при необходимости), увод КА с ГСО после окончания штатной эксплуатации проводится под постоянным контролем и управлением баллистической группы ЦУП НКУ КА «Ямал», что обеспечивает безопасность полета и исключает возможность столкновений с другими КА на орбите.

В состав бортовой аппаратуры КА «Ямал-200» входит оборудование, находящееся под давлением: НВАБ, БХП ксенона. Возможность разрушения указанного оборудования отсутствует, что обеспечивается значительными запасами прочности и подтверждено многочисленными наземными испытаниями и лётной квалификацией, более 20 миссий.

В процессе эксплуатации КА на ГСО и в процессе увода с ГСО исключены любые отделения элементов конструкции и агрегатов от КА «Ямал-200».

КА «Ямал-200» функционируют на геостационарной орбите в орбитальных позициях 90° в.д. и 49° в.д., в соответствии с поданной заявкой в МСЭ и в соответствии со всеми правовыми нормами МСЭ, таким образом возможность столкновения с другими КА по вине ОАО «Газком» исключена.

КА «Ямал-200» управляется в непрерывном режиме. Коррекция орбиты проводится стандартным образом в соответствии с планом коррекции орбиты.

Построение бортовых систем и принципы управления КА «Ямал-200» организованы таким образом, чтобы никакой одиночный отказ или ошибочно выданная единичная команда не приводили к несанкционированному включению двигателей.

4 УВОД С ОРБИТЫ КА «ЯМАЛ-200»

ОАО «Газком» запланированы следующие операции по уводу КА с орбиты после завершения САС:

1. Расчёт необходимого запаса рабочего тела для увода КА с ГСО после завершения эксплуатации.
2. Телеметрический контроль запасов рабочего тела ОДУ (ксенон) в течение всего срока эксплуатации (требование п.4.17.4.3 ТЗ на КА «Ямал-200»).
3. Увод КА с ГСО после окончания эксплуатации с соответствующими запасами рабочего тела ОДУ (требование п.4.17.4.3 ТЗ на КА «Ямал-200»). Перигей орбиты КА выведенного в область увода должен превышать радиус геостационарной орбиты не менее чем на 200 км (ОСТ 134-1023-2000). С учетом этого для КА «Ямал-200» принимается подъём высоты при уводе с ГСО равный 200км (300ГК.0000А201-0 ПЗ11 ч.12).

4. Как часть мероприятий по пассивации КА после вывода из эксплуатации предусматривается, что все источники энергии будут выключены, таким образом исключается возможность трансформации энергии бортовых источников питания в разрушающую. Указанные мероприятия включают:
   - перевод в неработоспособное состояние двигателей коррекции и ориентации (выключение источников питания). Необходимо отметить, что незначительные остатки рабочего тела двигательной установки (нейтральный газ ксенон) являются взрывобезопасными;
   - окончательный разряд аккумуляторных батарей по команде с НКУ после увода с ГСО;
   - отключение бортовой аппаратуры.
5. Во время увода КА с ГСО работа радиолинии СКУ будет планироваться исходя из исключения возможности появления помех в частотах других КА.

5 УВЕДОМЛЕНИЯ

ОАО «Газком» берет на себя обязательства предоставлять копии документов относящихся к данному вопросу как требует (РКА, IADS) со всеми соответствующими уведомлениями, как требуется по закону или нормам для аппаратов ОАО «Газком», включая, но не ограничивая вопросы ввода в эксплуатацию, орбитальную позицию, перевод в другую точку, изменение наклонения орбиты, переход на другую орбиту.

СПИСОК СОКРАЩЕНИЙ

БХП		блок хранения и подачи ксенона;
ГСО	-	геостационарная орбита;
КА	-	космический аппарат;
МСЭ		международный союз электросвязи;
НВАБ		никель-водородная аккумуляторная батарея;
НКУ	-	наземный комплекс управления;
ОДУ	-	объединенная двигательная установка;
ОКП	-	околоземное космическое пространство;
СКУ	-	служебный канал управления;
ЦУП	-	центр управления полетом;

Eutelsat W2A/Eutelsat 10A Space Debris Mitigation Plan (prepared for the Federal Communications Commission)

ISSUE/REVISION: Issue 1, Rev. 0

ISSUE DATE: 20 December 2012

Prepared by:	*Position*	*Signature*	*Date*
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Approved by:	*Position*	*Signature*	*Date*
L.R. Pattinson	Director of Satellite Operations		20/12/2012

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Date	*Issue/rev*	*Pages affected*	*Description*
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1. Introduction

This document describes the space debris mitigation plan that Eutelsat shall apply to the **Eutelsat W2A/10A** space station.

Eutelsat W2A/10A is based on the Thales Alenia Space Spacebus 4000 bus and it was manufactured according to European standards and specifications. The satellite is 3-axis stabilised and uses bi-propellant chemical propulsion for attitude and on-station control.

Eutelsat W2A/10A was launched in 2009 and the end of its operational life is not expected to be before early 2023.

2. Related documents

2.1. Applicable Documents

1. EUTELSAT Space Debris Mitigation Plan. Issue 1.3. EUT_CTL-SAT_QMS_PLN_00021, 26 July 2010.
2. FCC. Orbital Debris Mitigation Standard Practices. FCC 04-130. June 21, 2004.

2.2. Reference Documents

1. European Code of Conduct for Space Debris Mitigation. Issue 1.0. 28 June 2004.
2. IADC Space Debris Mitigation Guidelines. IADC-02-01. Revision 1. September 2007.
3. Space Product Assurance. Safety. ECSS-Q-40A. 19 April 1996.
4. Orbital Debris Mitigation Standard Practices. FCC 04-130. 21 June 2004.
5. NASA Safety Standard. Guidelines and Assessment Procedures for limiting Orbital Debris. NSS 1740.14. Aug 1995.
6. ITU Environment Protection of the Geostationary Orbit. S.1003. 1993.
7. UNCOPUOS. Technical Report on Space Debris. 1999.

3. Eutelsat W2A/10A operations

- Eutelsat operates in order to control and limit the amount of debris released in a planned manner during normal operations, and assesses and limits the probability of the space station becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal.
- Eutelsat has assessed the amount of debris released in a planned manner and no intentional debris will be released during normal operations of the Eutelsat W2A/10A spacecraft. A safe operational configuration of the satellite system is ensured thanks to the hardware design and operational procedures

- Eutelsat minimizes the probability of the satellite becoming a source of debris by collisions with large debris or other operational satellites. Eutelsat assessed for Eutelsat W2A/10A whether there were any known satellite located at the requested orbital location or might overlap.
- Eutelsat W2A/10A is controlled within its ITU allocated orbit control window (10.0°E +/- 0.1°) by standard routine periodic orbit correction manoeuvres. In case of anticipated violation of the window, correction manoeuvres would be implemented to avoid such violation.
- Eutelsat has assessed the probability of accidental explosions during and after completion of mission operations. Thanks to design safety margins and enough safety barriers, the probability of occurrence of accidental explosion of the Eutelsat W2A/10A satellite is negligible.
- Satellite design is such that high levels of thruster activity and orbit perturbation do not result when foreseeable on-board events occur

4. Eutelsat W2A/10A End of life disposal

The post-mission disposal activities have been planned as follows:

1. The orbit of the satellite will be raised by 300 km in order to ensure that the spacecraft will not re-enter into the GEO protected region (GEO height +/- 200 km) in the long term. A mass of 16.7 kg of propellant have been allocated and reserved with a confidence level of 99% to carry-out the post-mission disposal manoeuvres. The FCC will be informed of any significant change to the above quantity of propellant.

   The minimum perigee height to avoid re-entering into the GEO protected region can be computed using the IADC formula applied to this satellite:

   $$\Delta H \text{ (km)} = 235 + 1000.(A/m)_{eff} = 278 \text{ km}$$

   where the final term is the effective area/mass ratio of the satellite. Therefore, the planned 300 km above GEO height is sufficient to satisfy the 278 km requirement.

   During the satellite lifetime, Eutelsat determine the remaining propellant tanks.

2. As part of the end of life activities Eutelsat W2A/10A energy sources will be rendered inactive, such that debris generation will not result from the conversion of energy sources on board the spacecraft into energy that fragments the satellite. For Eutelsat W2A/10A , this involves the following:

- depleting the chemical propulsion system, and where possible leaving open fuel lines and valves.

The following table shows the characteristics of the pressurant tank, propellant tanks and propellant lines at end of life (EOL). It shall be noted that during the passivation the four propellant tanks will be depressurised as much as possible.

Element	Total Volume (l)	Material contained at EOL	Predicted mass of material at EOL (kg)
MON-1 Propellant tank	1391	MON-1 He	12.1 2.8
MMH propellant tank	1391	MMH He	3.8 3.0
MON-1 lines MMH lines	0.65 0.65	MON-1 MMH	1.0 0.6
Pressurant tank 1	90	He	0.9
Pressurant tank 2	90	He	0.9

It shall be noted that the Lithium-Ion batteries mounted on this satellite can not be depressurised. Nevertheless, they have been designed with a security coefficient greater than 3 and the batteries are "leak before burst" designed.

The heatpipes, which use ammonia as working fluid, can not be depressurised either. They have been designed with a security coefficient greater than 4, the risk of break-up is considered negligible.

- leaving all batteries in a state of permanent discharge by isolation of the battery charge circuits and leaving certain loads connected to the batteries.

3. The satellite tracking, TM and TC usage are planned so as to avoid electrical interference to other satellites and coordinated with any potential affected satellite networks.
4. During the orbit raising manoeuvres the tracking, TM and TC frequencies will be limited to those where the satellite is authorized to operate.

The design of the Eutelsat 10A spacecraft, fully consistent with end of life ("EOL") passivation requirements as existed at the time of construction, does not allow passive venting once the spacecraft has been switched-off. Therefore, none of the elements that

appear on the previous Table can be vented over time once the spacecraft has been switched-off. Nevertheless, as part of the passivation of the spacecraft during the EOL operations, Eutelsat always makes best-efforts to vent the propellant remaining in the propellant tanks and lines as much as possible. The figures in the last column of the Table can be considered as worst-case post-passivation remaining mass, after final shut-down of the satellite. In any case, the pressurant tank is isolated just after the completion of the launch and early orbit phase ("LEOP") operations and it cannot be passivated as part of the EOL operations.

5. Notifications

EUTELSAT undertakes to provide the relevant bodies as required (UNCOPUOS, FCC, ITU, French ANFR, etc) with all appropriate notifications as required by law or regulations for Eutelsat satellites including but not limited to those concerning initial entry of service, location, relocations, inclined orbit operations and re-orbiting operations.

Anik F1 Satellite
End of Life Disposal and Debris Mitigation Plan

This statement is prepared by Telesat Canada ("Telesat") for the purpose of assisting its customer in meeting the requirements in relation to the end of life disposal and debris mitigation of a telecommunication satellite. This information addresses requirements contained in §25.114(d)(14)(i)-(iv) of the Commission's rules.

Debris Release Assessment. ANIK F1 was launched on November 21, 2000, and began commercial operations in February 2001. Boeing performed the orbit raising and deployments of the spacecraft using their then-current best practices in accordance with their normal operations and procedures for a 702 spacecraft..

Spacecraft Hardware Design: The Anik F1 spacecraft is a reliable Boeing 702 spacecraft which is designed to withstand the harsh space environment. This bus has demonstrated years of safe operational performance.

Accidental Explosion Assessment. Telesat has reviewed failure modes for all equipment to assess the possibility of an accidental explosion onboard the spacecraft. In order to ensure that the spacecraft does not explode on orbit Telesat will continue to operate the satellite in accordance with Boeing's recommended procedures. All batteries and fuel tanks are monitored for pressure or temperature variations. Alarms in the SCC (Satellite Control Center) inform controllers of any variations. Additionally, long term trending analysis will be performed to monitor for any unexpected trends.

Operationally, batteries are operated utilizing the manufacturer's automatic recharging scheme. Doing so ensures that charging terminates normally without building up additional heat and pressure. As this process occurs wholly within the spacecraft, it also affords protection from command link failures (on the ground).

In order to protect the propulsion system, fuel tanks are operated in a blow down mode. At the completion of orbit raising, the pressurant was isolated from the fuel system. This will cause the pressure in the tanks to decrease over the life of the spacecraft. This will also protect from a pressure valve failure that could cause the fuel tanks to become over-pressurized.

In order to ensure that the spacecraft has no explosive risk after it has been successfully de-orbited, all stored energy onboard the spacecraft will be removed. Upon successful de-orbit of the spacecraft, all propulsion lines and latch valves will be vented and left open. All battery chargers will be turned off and batteries will be left in a permanent discharge state. These steps will ensure that no buildup of energy can occur resulting in an explosion in the years after the spacecraft is de-orbited.

Assessment Regarding Collision with Larger Debris and Other Space Stations. Telesat has also assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations.

Anik F1 operates in a collocated orbit with Anik F1R and (soon) Anik G1. Telesat will utilize industry standard, time proven techniques in the maneuvering of these collocated spacecraft. These are the same techniques that Telesat has and continues to use for its other collocated spacecraft.

In order to minimize the possibility of a large body impact collision, Telesat has assessed the proximity of other known Space Stations. In addition to working with all known neighbors, Telesat also utilizes three sources to identify collision risk. The first is alerts from the JSpOC for any approaching bodies. The second is the Space Data Center which utilizes our ephemeris as well as the ephemeris for all known bodies and provides us reports for potential collisions. The final is MIT/LL who utilizes its own radar and optical hardware to precisely provide data to Telesat for any close approach with debris.

Telesat continually monitors launch details to verify that no new spacecraft will take residence in the vicinity of the F1 spacecraft. In the event that some other spacecraft does locate within the vicinity of the F1 spacecraft, Telesat will work to coordinate orbits and station keeping strategies with the other spacecraft operators as it has done in the past with multiple other operators.

Post-Mission Disposal Plans. Anik F1, a Boeing built 702 bus, will be removed from its geostationary orbit at 107.3° W.L. at a perigee altitude no less than ~300 km above the standard geostationary orbit of 35786 km. This altitude was arrived at by using the FCC-recommended equation in §25.283 of the Commission's rules pertaining to end-of-life satellite disposal.

Minimum Deorbit Altitude= 235 km + (1000•CR•A/m) (Eq.1)
CR = solar pressure radiation coefficient of the spacecraft = 1.21
A/m = area to mass ratio, in square meters per kilogram, of the spacecraft = 0.0487

Result:
(Eq.1) Minimum Deorbit Altitude = 36,021 km + (1000·1.27•.0378) = 294 km

The propellant needed to achieve the minimum deorbit altitude is based on the delta-V required and specified by the spacecraft manufacturer.

Based on IADC calculation, an estimated end-of-life mass of 2700 kg, and the delta-V required, approximately 2 kg of propellant will be reserved to ensure minimum de-orbit altitude is obtained. It should be noted that F1 utilizes Xips thrusters (instead of normal Bi Prop). This means that Xenon is the basic fuel type (not Oxidizer (N204) and Fuel (MMH)). Xenon is much more efficient (which is why so little fuel is needed).

In addition to Xenon, there is also Oxidizer (N204) and Fuel (MMH) on board that was used during the orbit raising. In the event something happens to the Xenon system, it will be possible to de-orbit the spacecraft using the normal Fuel and Oxidizer.

Any remaining propellant will be consumed by further raising the orbit until combustion is no longer possible. The remaining species of Xenon propellant, Oxidizer (N204) or Fuel (MMH), will be vented, placing the propulsion system on the spacecraft in "safe" mode.

Propellant tracking is accomplished using a bookkeeping method. Using this method, the ground control station tracks the number of jet seconds utilized for station keeping, momentum control and other attitude control events. From jet seconds, amount of fuel used is determined. This process has been calibrated using data collected from thruster tests conducted on the ground and has been found to be accurate to within a few months of life on the spacecraft.

Apstar 6 and Apstar 7 Satellites

End of Life Disposal and Debris Mitigation Plan

This statement is prepared by APT Satellite Company Limited ("APT") for the purpose of assisting its customers who may be subject to the approval authority by such entities as the ITU, FCC USA or OFCA HK with regard to meeting the requirements in relation to the end of life disposal and debris mitigation of a telecommunications satellite.

Introduction:

Apstar 6 and Apstar 7 satellites of APT are manufactured and supplied by Thales Alenia Space France and are based on Space Bus 4000C2 series platform. They were launched on April 12, 2005 and March 31, 2012 respectively with nominal propellant life times to be 15.97 years and 19.67 years respectively after In Orbit Acceptance Review of the satellites.

Both satellites are 3-axis stabilized and use bi-propellant chemical propulsion for attitude and on-station control. The satellites are located at orbital slots 134° E.L. and 76.5° E.L., respectively. The TTC operation of both satellites is performed by APT Satellite SCC Department on basis of 7×24 through the ground station located in Tai Po, New Territory, Hong Kong. For station keeping, both satellites are maintained within a box in size of ±0.05 deg.

Disposal plan and debris mitigation measures:

As a licensed satellite operator in Hong Kong, APT will strictly comply with the requirements as stipulated by the "Guidelines for De-commissioning of Satellite" (the "Guidelines") issued by OFCA (Hong Kong Office of Communications Authority) and adhere to prevailing international best practices and standards to reduce space debris.

According to the said Guidelines, any expired satellite, which has to be de-orbited to the outer space, shall be disposed to an orbit with a delta-perigee (Δa) higher than geo-synchronous orbit of no less than:

$$235 \text{ km} + (1000 \cdot CR \cdot A/m)$$

where CR is the solar pressure radiation coefficient of the spacecraft, and A/m is the Area to mass ratio, in square meters per kilogram, of the spacecraft.

APT will take into account this requirement for any de-orbit operation of these satellites and will reserve sufficient propellant in order to conform to the regulation set forth in Guidelines.

	Δa requirement	Propellant needed
Apstar 6	290 km	8.26 kg
Apstar 7	297 km	10.94 kg

When APT applied for the Outer Space Ordinance License and Spacestation Carrier Licence from OFCA for Apstar 6 and Apstar 7, APT incorporated the respective disposal plan as well as debris mitigation measures in APT's submissions to OFCA. The licences for Apstar 6 and Apstar 7 were subsequently issued by OFCA to APT for the launches of these satellites.

Both Apstar 6 and Apstar 7 satellites are based on Space Bus 4000C2 platform, which is widely known to be a mature product and one of the most reliable satellite platforms. In the design phase, the satellite manufacturer, Thales Alenia Space France has already considered this potential issue and designed both satellites in such a way that industrial practices and standards are observed. There is no probable failure mode leading to accidental break-ups and cause space debris. Satellite manufacturer has established the dedicated SPACE DEBRIS MITIGATION PLAN. We therefore believe that both the design of these satellite and the disposal measures in place are in line with the regulations set forth in either IADC's Space Debris Mitigation Guidelines or FCC-04-130.

As each satellite is de-orbited, in addition to orbital raising operations, APT will configure the satellite with residual energy into a passive state. APT will implement procedures to minimize the on-board energy in whatever form of electrical, chemical, kinetic etc, which is considered as a potential source of generating harmful debris. These measures include shutting down the power generating subsystem and all power consumed components. Further, momentum wheels will be maintained at the lowest kinetic energy level. The propellant and pressurized tanks will be eventually depleted and vented. Pyrotechnic components in fact would have been executed or completely disabled during operations in the initial stage of life. As such, we consider the risk of de-commissioning of the satellites will be kept minimal and conformed to the standard of the industry.

Annexes:

Guidelines for De-commissioning of Satellite: issued by HK OFCA, 31 July 2007;
IADC Space Debris Mitigation Guidelines Revision 1: issued by IADC, Sep 2007;

-End-

APT Satellite Company Limited

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Chen Xun
Vice President