ATTACHMENT A

Technical Information to Supplement Schedule S

1. SCOPE

This attachment contains the information required by 47 C.F.R. §25.114 and other sections of the FCC's Part 25 rules that cannot be entered on Schedule S.

2. GENERAL DESCRIPTION

The ECHOSTAR-3 satellite will operate at the 86.4° W.L. orbital location using the UK Administration's IOMSAT-S21 ITU network. The satellite will be used to develop Broadcasting-Satellite Services ("BSS") to Chile and the South Pacific Ocean region.

The ECHOSTAR-3 satellite will operate in the 17.3-17.8 GHz BSS feeder uplink band (ITU Appendix 30A) and the 12.2-12.7 GHz BSS downlink band (ITU Appendix 30). The satellite's frequency plan is identical to that prescribed in the ITU's Region 2 BSS and associated feeder link Plan. Full frequency re-use is achieved through the use of dual orthogonal polarizations. The cross-polar isolation of the satellite's receive and transmit antennas exceed 30 dB.

The satellite will transmit on all even channels and on odd channels 5, 9, 13, 17, 21, 25 and 29. The maximum downlink EIRP level will be 54.7 dBW for the even channels and 54.2 dBW for the odd channels.

The primary feeder link site is expected to be located in Santiago, Chile. The telemetry, tracking and command ("TT&C") earth stations will be located at EchoStar's satellite control facilities in Cheyenne, WY, Gilbert, AZ, and Blackhawk, SD.

4. SERVICES TO BE PROVIDED

The ECHOSTAR-3 satellite will be used to develop mobile video and data applications to various Chilean and South Pacific regions. There will be one wideband digitally modulated signal transmitted in each of the active transponders, supporting a range of information data rates depending on the order of the modulation (*e.g.*, QPSK, 8PSK) and the type and degree of FEC coding used. Representative link budgets, which include details of the transmission characteristics, performance objectives and earth station characteristics, are provided in the associated Schedule S form. Link budgets for the TT&C transmissions are also included therein.

5. RECEIVER AND TRANSMITTER CHANNEL FILTER RESPONSE CHARACTERISTICS

The typical receiver and transmitter frequency responses of each RF channel, as measured between the receive antenna input and transmit antenna, fall within the limits shown in Table 5-1 below.

In addition, the frequency tolerances of §25.202(e) and the out-of-band emission limits of §25.202(f) (1), (2) and (3) will be met.

Table 5-1: Typical Receiver and Transmitter Filter Responses

Offset from Channel Center Frequency (MHz)	Receiver Filter Response (dB)	Transmitter Filter Response (dB)
± 5	> -0.35	> -0.35
± 7	> -0.55	> -0.45
±9	> -0.8	> -0.65
± 11	> -1.3	> -0.8
±12	> -1.8	> -0.9
±17.5	< -18	< -8
±20.2	< -38	< -18
±27.2	< -50	< -35

6. CESSATION OF EMISSIONS

Each active satellite transmission chain (channel amplifiers and associated TWTA) can be individually turned on and off by ground telecommand, thereby causing cessation of emissions from the satellite, as required.

7. TT&C

The TT&C earth stations will be located at EchoStar's satellite control facilities in Cheyenne, WY, Gilbert, AZ, and Blackhawk, SD. The satellite's near-omnidirectional beams will be used for TT&C purposes.

A summary of the on-station TT&C subsystem performance is given in Table 7-1.

Table 7-1: Summary of the on-station TT&C Subsystem Performance

Parameter	Performance
On-Station Command Frequency	17,301.5 MHz
Uplink Flux Density	-60 to -80 dBW/m^2
Uplink Polarization	Linear (Vertical)
On-Station Telemetry Frequencies	12,201.0 MHz 12,203.0 MHz 12,699.0 MHz
Maximum Downlink EIRP	3.2 dBW
Downlink Polarization	Linear (Vertical)

8. ORBITAL DEBRIS MITIGATION PLAN

8.1 Spacecraft Hardware Design

The ECHOSTAR-3 satellite was designed and manufactured by Lockheed Martin and was launched in 1997.

EchoStar has assessed and limited the amount of debris released during normal operations. The satellite was designed to minimize debris generated after separation from the launch vehicle and to cause no debris during normal on-station operations. All pyrotechnic devices onboard the satellite have been designed to retain all physical debris. In conjunction with the spacecraft manufacturer, EchoStar has assessed and limited the probability of the space station becoming a source of debris by collisions with small debris or meteoroids smaller than one centimeter in diameter that could cause loss of control and prevent post-mission disposal. The possibility of collisions with small debris and meteoroids was taken into account as part of the satellite design. EchoStar has taken steps to limit the effects of such collisions through the use of shielding, the placement of components, and the use of redundant systems. In addition, all sources of stored energy are located within the body of the spacecraft, thereby providing protection from small orbital debris.

8.2 Minimizing Accidental Explosions

EchoStar and Lockheed Martin have assessed and limited the probability of accidental explosions during and after completion of mission operations. The satellite was designed to ensure that debris generation does not result from the conversion of energy sources on board the satellite into energy that fragments the satellite. The propulsion subsystem pressure vessels have been designed to provide high safety margins. EchoStar and Lockheed Martin have limited the probability of accidental explosions during mission operations by means of a failure mode verification analysis. All pressures, including those of the batteries, will be monitored by telemetry. At end-of-life and once the satellite has been placed into its final disposal orbit, the batteries will be left in a permanent state of discharge and all sources of stored energy (with the exception of the oxidizer and helium tanks) will be vented at the spacecraft's end-of-life by leaving all fuel lines open. Because of Lockheed Martin's design of the spacecraft bus, however, the small amount of oxidizer and helium remaining in their respective tanks cannot be vented at the spacecraft's end of life. Instead, as explained in the attached Declaration from Lockheed Martin ("Lockheed Memorandum" included as Attachment B), this residual oxidizer and helium will be securely sealed and stored under conditions that would make a leak extremely unlikely, and an accidental, post-mission explosion more unlikely still.

As demonstrated in the Lockheed Memorandum, Lockheed has taken a number of measures to avoid an explosion. Specifically, first, it has built hardy tanks that are extremely unlikely to leak. The tanks are all-titanium pressure vessels that have been inspected, tested and qualified to the stringent requirements of the MIL-STD-1522A (Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems) and the EWR-127-1 (Eastern and Western Range Safety Requirements).[1] Given the small amount of oxidizer and helium that will remain in the oxidizer tanks, the tanks would have to be heated above 165° F (or 76° C) in order for their designed pressure tolerances to be exceeded. Such temperatures are highly unlikely to be experienced, and Lockheed's worst-case analysis shows that temperatures will be less than 95° F (or 35° C) at end-of-life, resulting in a maximum pressure well below the pressure tolerance of the tanks.[2] Similarly, the helium pressurant tanks that are sealed after the final propulsion system repressurization will retain a small residual of gaseous helium, but as with the oxidizer tanks, the worst case pressures are well below the design margin leaving little to no chance of explosions or leaks. Second, Lockheed has designed and constructed the tanks in accordance with stringent technical standards to leak rather than burst in the case of any flaw in the materials. The tanks have accordingly been qualified as leak-before-burst pressure vessels.[3]

The helium tanks were also built under the stringent MIL-STD-1522A (Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems) and the EWR-127-1 (Eastern and Western Range Safety Requirements). The maximum designed operating pressure of the helium tanks is 4500 psia at 30°C, still with a burst factor of 1.5:1 for additional safety margin. Based on manufacturer maximum expected temperatures of 35°C at disposal orbit, worst case helium tank pressures are predicted to be approximately 500 psia, far

[1] *See* Lockheed Memorandum at 1.
[2] *See id*. at 1.
[3] *See id*. at 1-2.

below the designed operational maximum pressures. The estimated total remaining mass of helium is expected to be 0. 226 kg after final spacecraft repressurization. Like the oxidizer tanks, the helium tanks by design are sealed off from the rest of the system upon the final propulsion system repressurization and therefore cannot be fully vented during end of mission maneuvers. However, because of the relatively low pressure at EOL, the possibility of helium tanks leaking or bursting is extremely unlikely.

For all of these reasons, the secure storage of the residual oxidizer and helium in this manner is no less safe than the venting of the oxidizer or residual helium. Tables showing the amount of residual oxidizer and helium are listed below.

Tank	***Volume (in^3)[4]***	***Liquid/ Gas***	***He (kg), End of Life***	***Internal T_{max} (C), Disposal Orbit***	***Internal P_{max} (psia), Disposal Orbit***
Oxidizer Tank #1	20,049	He	1.83 (amount remaining b/w the 2 oxidizer tanks)	35°	295
Oxidizer Tank #2	20,047	He		35°	295
Oxidizer Tank #1	20,049	N_2O_4	21.99 (amount remaining b/w the 2 oxidizer tanks)	35°	295
Oxidizer Tank #2	20,047	N_2O_4		35°	295
Pressurant Tank #1	4,157	He	0.226 (amount remaining b/w the 2 pressurant tanks)	20°	269[5]
Pressurant Tank #2	4,156	He		20°	269

EchoStar offers further explanation of the table as follows:

- The 0.226 kg of helium was calculated using the spacecraft manufacturer's estimate of the mass of helium remaining in the tanks following the first repressurization of the hydrazine tanks, coupled with an estimate of the mass of helium required to bring the hydrazine and helium tanks near equilibrium during the final repressurization of the

[4] 1 in^3 is equivalent to 1.6387 x 10^{-5} cubic meters.

[5] This pressure is well below the burst pressure for the Helium tanks. The spacecraft manufacturer's documentation for the satellite states that "The maximum expected operating pressure (MEOP) of each pressurant tank is 4500 psia with a 1.5:1 burst factor of safety."

hydrazine tank prior to end-of-life maneuvers.

- The 35 degrees Celsius maximum internal temperature for the helium tanks in the disposal orbit is taken from the spacecraft manufacturer's prediction of the worst case temperature for the spacecraft in this orbit.

- The 500 pounds per square inch area ("psia") maximum internal pressure for the helium tanks in the disposal orbit is also taken from the spacecraft manufacturer's operations manual for the satellite; the pressure was not calculated using the figures contained in the above table. Notably, EchoStar estimates that the average pressure in the tanks will be well below the maximum estimated by the manufacturer. Specifically, calculations using the ideal gas law, an average temperature of 20° Celsius, and the above-referenced helium mass and tank volumes produce an estimated average pressure for the helium tanks of approximately 269 psia.

Residual Helium Cannot Be Vented:

Prior to end-of-life maneuvers, the helium will be used to repressurize the hydrazine tank. Once the pressure in the hydrazine tank is in equilibrium with the pressure in the helium tanks, no further helium can migrate from the helium tanks to the hydrazine tank, and the helium tanks will be isolated from the rest of the spacecraft via latch valve in accordance with the spacecraft manufacturer's recommendation. There is no manufacturer recommended mechanism to vent the residual helium from the helium tanks themselves after the final repressurization of the hydrazine tank.

The Commission may waive its rules for "good cause shown," including in cases where compliance would impose an undue hardship and the policy underlying the rule will still be served.[6] These circumstances are met here. First, of course, EchoStar 3 is incapable of alteration at this stage. It was designed and launched before the adoption of the Commission's current orbital debris mitigation rules. The Commission is well aware of the limitations of the Lockheed Martin A2100 spacecraft.[7] The bus design makes it impossible to vent the residual

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[6] *See* 47 C.F.R. § 1.3; *WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969); *see also* Stamp Grant, IBFS File No. SAT-STA-20080219-00048, SAT-STA-20080229-00054 (Mar. 12, 2008) (explaining that "waiver is granted because modification of the [Lockheed Martin A2100] spacecraft would present an undue hardship, given the late stage of satellite construction.").

[7] *See infra* n. 6.

oxidizer and helium at the satellite's end of life. At the same time, it is extremely unlikely that the oxidizer or helium tanks will leak or burst. This means that the chance of accidental explosions has been minimized, consistent with the purpose of Sections 25.283(c) and 25.114(d)(14)(ii) of the Commission's rules.[8] For these reasons, the Commission has repeatedly granted waivers of Sections 25.283(c) and 25.114(d)(14)(ii) of the Commission's rules for satellites based on the A2100 bus.[9]

Based upon the foregoing, the Commission should grant the requested waiver.

8.3 Safe Flight Profiles

In considering current and planned satellites that may have a station-keeping volume that overlaps the ECHOSTAR-3 satellite, EchoStar has reviewed the lists of FCC-licensed satellite networks, as well as those that are currently under consideration by the FCC. In addition, networks for which a request for coordination has been published by the International Telecommunication Union ("ITU") within ±0.15° of 86.4° W.L. have been reviewed.

Based on these reviews, EchoStar concludes that there are no operational or planned satellites that could have a station-keeping overlap with the ECHOSTAR-3 satellite. Telesat Canada operates the NIMIQ 1 satellite nominally at 86.5° W.L. with an east-west station-keeping tolerance of 0.05 degrees. EchoStar will maintain the ECHOSTAR-3 satellite at the 86.4° W.L. orbital location, with an east-west station-keeping tolerance of 0.05 degrees, thereby ensuring there is no possibility of station-keeping volume overlap between the two satellites.

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[8] *See* 47 C.F.R. § 25.114(d)(14)(ii) (addressing the discharge of energy sources in the context of requiring satellite operators to assess and limit "the probability of accidental explosions during and after completion of mission operations"); *WAIT Radio*, 418 F.2d at 1157 (noting that a waiver may be granted when it would not undermine the purpose of the rule); *Intelsat North America LLC*, 22 FCC Rcd. 11989 ¶ 6 (2007).

[9] Stamp Grants, SES Americom, Inc., File No. SAT-MOD-20121224-00221, Call Sign S2181, at condition 5 (Mar. 22, 2013); SES Americom, Inc., File No. SAT-MOD-20111220-00243, Call Sign S2162, at condition 7 (June 28, 2012); Intelsat License LLC, File No. SAT-RPL-20120216-00018, Call Sign S2854, at condition 4 (May 25, 2012); New Skies Satellites B.V., File No. SAT-MPL-20120215-00017, Call Sign S2463, at condition 7 (May 25, 2012); SES Americom, Inc., File No. SAT-MOD-20110718-00130, Call Sign S2445, at condition 2 (Oct. 13, 2011); EchoStar Satellite Operating Corp., File No. SAT-LOA-20071221-00183, at condition 4 (Mar. 12, 2008).

Based on the preceding, EchoStar concludes that there is no requirement to physically coordinate the ECHOSTAR-3 satellite with another satellite operator at the present time.

8.4 Post Mission Disposal

Upon mission completion, the ECHOSTAR-3 satellite will be maneuvered to a disposal orbit at least 270 km above its operational geostationary orbit.[10] Based on data from the satellite manufacturer, less than 12 kg of fuel will be required to achieve this. Accordingly, 12 kg of fuel will be reserved at the end of the satellite's life. The fuel reserve will be calculated using two methods. The first method is the pressure-volume temperature method, which uses tank pressure and temperature information to determine remaining propellant. The second method is the bookkeeping method, which evaluates the flow rate at average pressure and total thruster on-time of orbital maneuvers to determine the amount of propellant used. EchoStar has assessed fuel gauging uncertainty and has provided an adequate margin of fuel to address such uncertainty.

9. INTERFERENCE ANALYSES - ANNEXES 1 TO APPENDICES 30 AND 30A

The ECHOSTAR-3 satellite at 86.4° W.L. will operate under the UK Administration's IOMSAT-S21 network filings with the ITU. Accordingly, EchoStar, through the UK Administration, is responsible for coordination of the ECHOSTAR-3 satellite following the Appendix 30 and 30A coordination procedures.

The analyses of the ECHOSTAR-3 satellite network at 86.4° W.L. with respect to the limits in Annex 1 to Appendices 30 and 30A are given in Appendices 1 and 2 to this attachment. The results of these analyses are discussed below.

The Appendices show that the ECHOSTAR-3 satellite network meets the ITU criteria in Annex 1, except for § 4.2.3(c) of Article 4 of Appendices 30 and 30A. There are three adjacent Region

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[10] The ECHOSTAR-3 satellite was launched in 1997. Pursuant to the Commission'srules, a calculation of the satellite's disposal orbit according to the IADC formula is not required. *See Mitigation of Orbital Debris*, Second Report and Order, 19 FCC Rcd 11567, ¶ 81(2004) ("we will grandfather all on orbit GEO spacecraft that were launched as of the release of the *Notice* in this proceeding").

2 BSS networks that are deemed to be affected. These networks belong to the Bahamas, Peru and the USA. None of these networks is operational. Each of the networks is discussed below:

- The ECHOSTAR-3 satellite will operate under the IOMSAT-S21 ITU network. The Bahamas did not comment on the IOMSAT-S21 network when it was published by the ITU. The OEPM degradation caused to the Bahamian network by the ECHOSTAR-3 satellite network is less than that caused by the IOMSAT-S21 network and therefore there is no requirement to coordinate with the Bahamas.

- Similar to the Bahamas, Peru did not comment on the IOMSAT-S21 network when it was published by the ITU. The OEPM degradation caused to the Peruvian network by the ECHOSTAR-3 satellite network is less than that caused by the IOMSAT-S21 network and therefore there is no requirement to coordinate with Peru.

- The USA's USABSS-27 network at 86.5° W.L. is deemed to be affected. This network was submitted to the ITU on behalf of EchoStar. In July 2011, the International Bureau determined that EchoStar had failed to meet the critical design review milestone for its authorization at 86.5° W.L. and declared the authorization null and void. Accordingly, it is expected that the USABSS-27 network will not be brought-into-use before the requisite eight-year period, and that the ITU will subsequently suppress the network.

In addition to the above, there are two UK ITU networks at 86.5° W.L. Coordination of the IOMSAT-S21 network with these two other UK networks is a domestic matter for OFCOM. The two other UK networks were filed on behalf of SES Satellites (GIB), LTD ("SES"). The NIMIQ 1 satellite, located at 86.5° W.L., operates under these UK networks. EchoStar and SES have a coordination agreement for operation of their respective networks.

The preceding demonstrates that there is no possibility of the ECHOSTAR-3 satellite network causing harmful interference into another network.

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this application and that it is complete and accurate to the best of my knowledge and belief.

/s/ Stephen D. McNeil

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Appendix 1 to
Attachment A (Technical Information to Supplement Schedule S)

Analysis of ANNEX 1 of Appendix 30

1 Limits for the interference into frequency assignments in conformity with the Regions 1 and 3 Plan or with the Regions 1 and 3 List or into new or modified assignments in the Regions 1 and 3 List

Not Applicable to Region 2.

2 Limits to the change in the overall equivalent protection margin for frequency assignments in conformity with the Region 2 plan

With respect to § 4.2.3 c) of Article 4, an administration in Region 2 is considered as being affected if the overall equivalent protection margin corresponding to a test point of its entry in the Region 2 Plan, including the cumulative effect of any previous modification to that Plan or any previous agreement, falls more than 0.25 dB below 0 dB, or, if already negative, more than 0.25 dB below the value resulting from:

- *the Region 2 Plan as established by the 1983 Conference; or*
- *a modification of the assignment in accordance with this Appendix; or*
- *a new entry in the Region 2 Plan under Article 4; or*
- *any agreement reached in accordance with this Appendix. (WRC-03)*

The MSPACE analysis was performed utilizing the Region 2 BSS Plan as contained in IFIC 2697; the IFIC in which the IOMSAT-S21 network was published. The results of the analysis are contained in Annex 1 to this Appendix.

3 Limits to the change in the power flux-density to protect the broadcasting-satellite service in Regions 1 and 2 in the band 12.2-12.5 GHz and in Region 3 in the band 12.5-12.7 GHz

With respect to § 4.2.3 a), 4.2.3 b) or 4.2.3 f) of Article 4, as appropriate, an administration in Region 1 or 3 is considered as being affected if the proposed modification to the Region 2 Plan would result in exceeding the following power flux-density values, at any test point in the service area of its overlapping frequency assignments:

$$-147 \quad dB(W/(m^2 \cdot 27\ MHz)) \qquad for\ 0^\circ \le \theta < 0.23^\circ$$
$$-135.7 + 17.74 \log \theta \quad dB(W/(m^2 \cdot 27\ MHz)) \qquad for\ 0.23^\circ \le \theta < 2.0^\circ$$
$$-136.7 + 1.66\ \theta^2 \quad dB(W/(m^2 \cdot 27\ MHz)) \qquad for\ 2.0^\circ \le \theta < 3.59^\circ$$
$$-129.2 + 25 \log \theta \quad dB(W/(m^2 \cdot 27\ MHz)) \qquad for\ 3.59^\circ \le \theta < 10.57^\circ$$
$$-103.6 \quad dB(W/(m^2 \cdot 27\ MHz)) \qquad for\ 10.57^\circ \le \theta$$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies.   (WRC-03)

The closest Regions 1 and 3 BSS network is the Russian INTERSPUTNIK-47.5W-B network at 47.5°W, which is greater than 10.57 degrees from the 86.4° W.L. location, therefore the –103.6 dB(W/(m^2 . 27 MHz)) PFD level applies for this network and all other Regions 1 and 3 networks. The GIMs Appendix 30 PFD tool was used to assess compliance with this Section. Using the antenna gain contours and power levels of the beams of the ECHOSTAR-3 satellite, the GIMS PFD tool showed that no administrations are affected. Therefore the ECHOSTAR-3 satellite network is compliant with this Section.

4 Limits to the power flux-density to protect the terrestrial services of other administrations

With respect to § 4.1.1 d) of Article 4, an administration in Region 1, 2 or 3 is considered as being affected if the consequence of the proposed modified assignment in the Regions 1 and 3 List is to increase the power flux-density arriving on any part of the territory of that administration by more than 0.25 dB over that resulting from that frequency assignment in the Plan or List for Regions 1 and 3 as established by WRC-2000. The same administration is considered as not being affected if the value of the power flux-density anywhere in its territory does not exceed the limits expressed below.

With respect to § 4.2.3 d) of Article 4, an administration in Region 1, 2 or 3 is considered as being affected if the consequence of the proposed modification to an existing assignment in the Region 2 Plan is to increase the power flux-density arriving on any part of the territory of that administration by more than 0.25 dB over that resulting from that frequency assignment in the Region 2 Plan at the time of entry into force of the Final Acts of the 1985 Conference. The same administration is considered as not being affected if the value of the power flux-density anywhere in its territory does not exceed the limits expressed below.

With respect to § 4.1.1 d) or § 4.2.3 d) of Article 4, an administration in Region 1, 2 or 3 is considered as being affected if the proposed new assignment in the Regions 1 and 3 List, or if the proposed new frequency assignment in the Region 2 Plan, would result in exceeding a power flux-density, for any angle of arrival, at any point on its territory, of:

-148 dB(W/(m^2 $\cdot$ 4 kHz))	for $\theta \leq 5°$
$-148 + 0.5\,(\theta - 5)$ dB(W(m^2 $\cdot$ 4 kHz)	for $5° < \theta \leq 25°$
-138 dB(W/(m^2 $\cdot$ 4 kHz))	for $25° < \theta \leq 90°$

where θ represents the angle of arrival.   (WRC-03)

The GIMS PFD tool was used to determine the administrations whose terrestrial services may be affected by the ECHOSTAR-3 satellite network. Using this tool, the results show that the PFD limits are not exceeded over the territory of any administration and therefore the ECHOSTAR-3 satellite is compliant with this Section.

5 Limits to the change in the power flux-density of assignments in the Regions 1 and 3 Plan or List to protect the fixed-satellite service (space-to-Earth) in the band 11.7-12.2 GHz in Region 2 or in the band 12.2-12.5 GHz in Region 3, and of assignments in the Region 2 Plan to protect the fixed-satellite service (space-to-Earth) in the band 12.5-12.7 GHz in Region 1 and in the band 12.2-12.7 GHz in Region 3

With respect to § 4.2.3 e), an administration is considered as being affected if the proposed modification to the Region 2 Plan would result in an increase in the power flux-density over any portion of the service area of its overlapping frequency assignments in the fixed-satellite service in Region 1 or 3 of 0.25 dB or more above that resulting from the frequency assignments in the Region 2 Plan at the time of entry into force of the Final Acts of the 1985 Conference.

The analysis shows that the PFD levels produced by the ECHOSTAR-3satellite are less than those resulting from the frequency assignments in the Region 2 Plan at the time of entry into force of the Final Acts of the 1985 Conference and therefore the ECHOSTAR-3 satellite network is compliant with this Section.

6 Limits to the change in equivalent noise temperature to protect the fixed-satellite service (Earth-to-space) in Region 1 from modifications to the Region 2 Plan in the band 12.5-12.7 GHz

With respect to § 4.2.3 e) of Article 4, an administration of Region 1 is considered as being affected if the proposed modification to the Region 2 Plan would result in:

– *the value of $\Delta T / T$ resulting from the proposed modification is greater than the value of $\Delta T / T$ resulting from the assignment in the Region 2 Plan as of the date of entry into force of the Final Acts of the 1985 Conference; and*
– *the value of $\Delta T / T$ resulting from the proposed modification exceeds 6%, using the method of Appendix **8** (Case II). (WRC-03)*

From a review of the available ITU space network databases there are no assignments registered in the Earth-to-space direction in the frequency band 12.5-12.7 GHz. Therefore no Region 1 space stations can be affected and the ECHOSTAR-3 satellite network is compliant with this Section.

<u>**Annex 1 to Appendix 1 to Attachment A**</u>

<u>**ECHOSTAR-3 at 86.4° W.L. MSPACE Results**</u>

Admin	Orbital Position (°W)	Network	Max. OEPM Degradation (dB)
BAH	87.20	BAHIFRB1	0.730
PRU	85.80	PRU00004	2.990
USA	86.50	USABSS-27	1.442

Appendix 2 to
Attachment A (Technical Information to Supplement Schedule S)

Analysis of ANNEX 1 of Appendix 30A

1 Limits to the change in the overall equivalent protection margin with respect to frequency assignments in conformity with the Region 2 feeder-link Plan (WRC-2000)

With respect to the modification to the Region 2 feeder-link Plan and when it is necessary under this Appendix to seek the agreement of any other administration of Region 2, except in cases covered by Resolution ***42 (Rev.WRC-03)****, an administration is considered as being affected if the overall equivalent protection margin corresponding to a test point of its entry in that Plan, including the cumulative effect of any previous modification to that Plan or any previous agreement, falls more than 0.25 dB below 0 dB, or, if already negative, more than 0.25 dB below the value resulting from:*

- *the feeder-link Plan as established by the 1983 Conference; or*
- *a modification of the assignment in accordance with this Appendix; or*
- *a new entry in the feeder-link Plan under Article 4; or*
- *any agreement reached in accordance with this Appendix except for Resolution* ***42 (Rev.WRC-03)****. (WRC-03)*

See the results described under Section 2 of the Appendix 30 Annex 1 Analysis.

2 Limits to the interference into frequency assignments in conformity with the Regions 1 and 3 feeder-link Plan or with the Regions 1 and 3 feeder-link List or proposed new or modified assignments in the Regions 1 and 3 feeder-link List (WRC-03)

Not Applicable to Region 2.

3 Limits applicable to protect a frequency assignment in the bands 17.3-18.1 GHz (Regions 1 and 3) and 17.3-17.8 GHz (Region 2) to a receiving space station in the fixed-satellite service (Earth-to-space)

An administration in Region 1 or 3 is considered as being affected by a proposed modification in Region 2, with respect to § 4.2.2 a) or 4.2.2 b) of Article 4, or an administration in Region 2 is considered as being affected by a proposed new or modified assignment in the Regions 1 and 3 feeder-link List, with respect to § 4.1.1 c) of Article 4, when the power flux-density arriving at the receiving space station of a broadcasting-satellite feeder-link would cause an increase in the noise temperature of the feeder-link space station which exceeds the threshold value of $\Delta T / T$ *corresponding to 6%, where* $\Delta T / T$ *is calculated in accordance with the method given in Appendix* ***8****, except that the maximum power densities per hertz averaged over the worst 1 MHz are replaced by power densities per hertz averaged over the necessary bandwidth of the feeder-link carriers. (WRC-03)*

The analysis shows that there are no affected Region 1 or Region 3 networks.

4 Limits applicable to protect a frequency assignment in the band 17.8-18.1 GHz (Region 2) to a receiving feeder-link space station in the fixed-satellite service (Earth-to-space) (WRC-03)

With respect to § 4.1.1 d) of Article 4, an administration is considered affected by a proposed new or modified assignment in the Regions 1 and 3 feeder-link List when the power flux-density arriving at the receiving space station of a broadcasting-satellite feeder-link in Region 2 of that administration would cause an increase in the noise temperature of the receiving feeder-link space station which exceeds the threshold value of $\Delta T/T$ *corresponding to 6%, where* $\Delta T/T$ *is calculated in accordance with the method given in Appendix* ***8****, except that the maximum power densities per hertz averaged over the worst 1 MHz are replaced by power densities per hertz averaged over the necessary bandwidth of the feeder-link carriers. (WRC-03)*

Not Applicable to Region 2.

ATTACHMENT B

LOCKHEED MEMORANDUM

Lockheed Martin Space Systems

LOCKHEED MARTIN

Engineering Memorandum

Program: A2100		Date: 18 December 2007
Title: EOL A2100 Oxidizer System Pressures		EM No.: PSS07-A2100-0040
Key Words: End of Life, Oxidizer, Pressures		
Prepared For: B. Noakes LMCSS Chief Engineer	Prepared by: J. Henderson LM Propulsion Fellow 12-18-07	

1.0 Summary

Currently, the A2100 propulsion system has no way to vent off the oxidizer tanks following transfer orbit. The pressure and residual oxidizer is sealed via pyrotechnic valves in the two oxidizer tanks. We consider it very unlikely that these tanks could catastrophically lose pressure either during the mission or after the spacecraft has been placed in a disposal orbit.

2.0 Background

The oxidizer tanks are all titanium pressure vessels that have been inspected, tested and qualified to the requirements of the MIL-STD-1522A (Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems) and the EWR-127-1 (Eastern and Western Range Safety Requirements) as hazardous leak before burst pressure vessels. These documents place stringent requirements on the design, manufacturing, test and operation of the pressure vessels so that it is extremely unlikely that these tanks will leak external and even more unlikely that they would rupture with explosive force. The leak before burst requirement was demonstrated on the qualification tank.

Specifically, the tanks are designed to a Maximum Expected Operating Pressure of 300 psia, and are proof tested during manufacturing and after system integration to 375 psia. The tanks are designed such that their rupture pressure is not less than 450 psig – the qualification test unit for this tank design actually ruptured at 664 psig. At the end of transfer orbit, the tanks have between 255 – 265 psia inside them. The maximum expected amount of remaining oxidizer is less than 3% of the tank volume. To get the tanks to a pressure above the design rupture pressure, the tank temperature would have to increase to above 165 F (76 C). Analysis of the spacecraft at end of life indicates a worst case temperature less than 95 F(35 C), with a corresponding maximum pressure in the tanks less than 295 psia. Therefore, there is no risk of rupture of the tanks after retirement of the spacecraft. The other failure mode for the tank is leakage. The tanks are designed such that they will leak before they burst – the tank materials have been inspected to such an extent that flaws, if they are present in the material, will not propagate catastrophically – they will growth through the wall and the tank will leak, relieving the pressure, rather than grow in a manner that the stored energy in the tank will be released in an instant. Because of this design, the tanks will not fail in such a manner that debris is generated.

3.0 Conclusion

It is extremely unlikely that the oxidizer system in an A2100 will catastrophically lose pressure after the system has been isolated following transfer orbit.