Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of Application by	)	
	)	
XM Radio Inc.	)	File No. SAT-MOD-_____
	)	Call Sign S2616
For Modification of the XM-4 License	)	

APPLICATION OF XM RADIO INC.

XM Radio Inc. ("XM Radio")[1], a satellite digital audio radio service ("SDARS") licensee, hereby applies for a modification of the license for its XM-4 spacecraft, Call Sign S2616, to reassign the satellite from its current orbital position of 115.0° W.L. to 115.25° W.L. and operate it there with a +/-.1 degree east-west stationkeeping tolerance. XM Radio seeks to operate XM-4 at an offset from 115.0° W.L. in order to simplify physical stationkeeping and requests an expanded stationkeeping volume at the new orbital location to permit collocation of XM-4 with XM-1, and XM-2. The latter are in-orbit spare SDARS spacecraft and are currently positioned near 85.2° W.L. XM Radio will separately be seeking authority to move XM-1 and XM-2 to 115.25° W.L. +/-.1 degree following the launch of a new spare satellite, XM-5, to 85.2° W.L. No other change in the operation of the XM-4 spacecraft is proposed.

A completed FCC Form 312 is attached, and XM Radio incorporates by reference the technical information previously provided in support of XM-4.[2] In addition, XM Radio is providing here technical information relating to the proposed modification to the XM-4 license in narrative form pursuant to Section 25.114 of the Commission's Rules. Grant of the requested

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1 XM Radio is a wholly-owned subsidiary of Sirius XM Radio Inc. ("Sirius XM").

2 *See* File No. SAT-RPL-20040212-00018, Call Sign S2616.

authority will serve the public interest by facilitating safe and efficient operation of XM-4 in support of XM Radio's SDARS network.

MODIFICATION

XM-4 is an SDARS satellite that was launched and commenced operations at 115.0° W.L. pursuant to Commission license in 2006.[3] Subsequent to XM-4's entry into service, the Commission has issued two other authorizations in the vicinity of the 115° W.L. orbital location. In 2008, Pegasus Development DBS Corp. ("Pegasus") was authorized to construct, launch and operate a 17/24 GHz Broadcasting-Satellite Service space station at 115.0° W.L., subject to coordination of physical stationkeeping with other operators having overlapping assigned stationkeeping volumes.[4] In 2009, ViaSat, Inc. ("ViaSat") was granted authority to serve the U.S. market from an Isle of Man-licensed Ka-band spacecraft to be positioned at 115.1° W.L.[5] In addition, the Mexican-licensed Solidaridad 2 spacecraft operates just to the east of XM-4 at 114.9° W.L.

Given these other spacecraft authorized for positions at or near the current XM-4 orbital location, XM Radio does not have the flexibility to collocate other spacecraft in its fleet immediately adjacent to XM-4. XM Radio has decided to seek authority to relocate XM-4 to 115.25° W.L. in order to avoid the congestion surrounding 115.0° W.L. In addition, the proposed shift will restore XM Radio's flexibility to deploy its spare spacecraft to positions

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3 *See XM Radio Inc.*, 20 FCC Rcd 1620 (Sat. Div. 2005).

4 *Pegasus Development DBS Corp.*, File Nos. SAT-LOA-20060412-00044 & SAT-AMD-20080114-00023, Call Sign S2700, grant-stamped Dec. 17, 2008.

5 *ViaSat, Inc.*, File Nos. SAT-LOI-20080107-00006, SAT-AMD-20080623-00131, & SAT-AMD-20090213-00023, Call Sign S2747, grant-stamped Aug. 18, 2009.

where they can immediately be used to restore service in the event of an outage affecting XM Radio's primary spacecraft, without the need to repoint feeder link ground antennas.

XM Radio also requests authority to operate XM-4 with a greater east-west stationkeeping tolerance of +/- 0.1 degrees. Upon arrival of XM-1 and XM-2 at the nominal 115.25° W.L. orbital location, XM Radio plans to operate all three spacecraft in formation. The larger requested stationkeeping volume for the three satellites will facilitate safe operation of the spacecraft and conserve fuel, prolonging their useful life.[6]

As demonstrated in the attached technical appendix, grant of the request to reassign XM-4 and operate it with an increased stationkeeping volume will not adversely affect any other satellite operators. Relocation of XM-4 as requested will eliminate the overlap between the stationkeeping volumes assigned to XM-4 and to the Pegasus 17/24 GHz satellite and will not create an overlap with the assigned stationkeeping volume of the ViaSat satellite. At its proposed orbital location of 115.25° W.L. +/- 0.1 degrees, XM-4 will not have a stationkeeping volume that overlaps with those of any other satellites except for the stationkeeping volumes that will subsequently be proposed for XM-1 and XM-2.[7]

Furthermore, the proposed reassignment of XM-4 will not cause harmful interference to any other satellite operators. There are no satellites using either the S-band or X-band frequencies assigned to XM-4 currently operating within two degrees of 115.25° W.L., and

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[6] Upon initial arrival of XM-4 at 115.25° W.L., prior to the relocation of XM-1 and XM-2, XM Radio will operate XM-4 within a standard stationkeeping volume of +/- 0.05 degrees. In order to avoid the need to file a further modification of the XM-4 license, however, XM Radio is requesting authority here to operate XM-4 in an expanded stationkeeping volume upon arrival of a co-located spacecraft at 115.25° W.L.

[7] XM Radio's affiliate, Satellite CD Radio, has a pending application to launch and operate the FM-6 satellite at 115.2° W.L. *See* File No. SAT-LOA-20100409-00072. XM Radio will coordinate with its affiliate regarding the placement and operation of FM-6 at or near the 115.2° W.L. orbital location.

no such operations are planned except for other satellites operated by XM Radio. XM Radio does not share S-band spectrum with other satellite systems, and the SDARS downlink frequencies are not subject to two degree spacing rules.

The Commission has generally permitted satellite operators the flexibility to design and modify their networks in response to customer requirements, provided there are no compelling countervailing public interest considerations.[8] In addition, the Commission has consistently recognized that ensuring continuity of service is an important public interest objective.[9] The requested modification will allow XM Radio to operate XM-4 in formation with XM-1 and XM-2 in the stationkeeping volume bounded by 115.15º W.L. and 115.35º W.L. and will serve the public interest by permitting XM Radio to optimize use of its satellite assets to ensure service reliability.

WAIVER REQUESTS

XM Radio requests limited waivers of the Commission's requirements in connection with the requested XM-4 license modification. Grant of these waivers is consistent with Commission policy:

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[8] *See, e.g. AMSC Subsidiary Corporation*, 13 FCC Rcd 12316 at ¶ 8 (IB 1998) (the Commission generally leaves space station design decisions to the licensee "because the licensee is in a better position to determine how to tailor its system to meet the particular needs of its customers.") (footnote omitted).

[9] *See, e.g., DIRECTV Enterprises, LLC, Request for Special Temporary Authority to Conduct Telemetry, Tracking and Control During the Relocation of DIRECTV 1 to the 72.5º W.L. Orbital Location*, Order and Authorization, DA 05-1890 (Sat. Div. rel. July 14, 2005) at ¶ 18 (granting STA to relocate spacecraft to a location where it will replace a satellite with failing solar panels "will enable DIRECTV to maintain continuity of DBS service to its customers"); *DIRECTV Enterprises, LLC, Application for Authorization to Operate DIRECTV 5, a Direct Broadcast Satellite, at the 109.8º W.L. Orbital Location*, Order and Authorization, DA 05-2654 (Sat. Div. rel. Oct. 5, 2005) at ¶ 8 ("DIRECTV's proposal to provide DBS service from this location will serve the public interest, convenience and necessity in that it will ensure continuity of service to DIRECTV subscribers").

> The Commission may waive a rule for good cause shown. Waiver is appropriate if special circumstances warrant a deviation from the general rule and such deviation would better serve the public interest than would strict adherence to the general rule. Generally, the Commission may grant a waiver of its rules in a particular case if the relief requested would not undermine the policy objective of the rule in question and would otherwise serve the public interest.[10]

Section 25.210(j): Section 25.210(j) of the Commission's rules specifies that geostationary space stations "must be maintained within 0.05º of their assigned orbital longitude in the east/west direction, unless specifically authorized by the Commission to operate with a different longitudinal tolerance." 47 C.F.R. § 25.210(j). The Commission has previously found a waiver of this rule justified based on a finding that allowing an increased stationkeeping volume would "not adversely affect the operations of other spacecraft, and would conserve fuel for future operations."[11] In addition, the Commission has waived the rule to allow operation of multiple space stations in formation within a combined stationkeeping volume.[12]

The facts here fit squarely within this precedent. As discussed herein, allowing XM-4 to operate within an increased stationkeeping volume will not harm other operators. The only satellites with which XM-4's stationkeeping volume will overlap are other spacecraft in the XM Radio fleet. XM Radio will ensure that the satellites' flight is closely controlled to ensure

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[10] *PanAmSat Licensee Corp.*, 17 FCC Rcd 10483, 10492 (Sat. Div. 2002) (footnotes omitted).

[11] *SES Americom, Inc. Application for Modification of Satcom SN-4 Fixed Satellite Space Station License*, 20 FCC Rcd 11542, 11545 (Sat. Div. 2005).

[12] *See SES Americom, Inc.*, File No. SAT-MOD-20080314-00072, Call Sign S2135, grant-stamped May 19, 2008 at ¶ 1 ("We agree with SES Americom that increasing the station-keeping volume of the AMC-4 spacecraft will not adversely affect the operations of other spacecraft, will conserve fuel for future operations and will facilitate coordinated operation of AMC-4 and AMC-2 in the same station-keeping range.").

their safe joint operation. Furthermore, the proposed operations will not materially affect the interference environment.

Finally, allowing XM-4 to be flown in formation with XM-1 and XM-2 in an east-west stationkeeping volume of +/-0.1 degree will result in fuel savings for all three spacecraft. This will prolong the time during which XM-1 and XM-2 will be available to provide any needed back-up capacity for XM-3 and XM-4. Under these circumstances, XM Radio submits that grant of any necessary waiver of Section 25.210(j) will serve the public interest.

Section 25.283(c): XM Radio also requests any necessary waiver of the requirements of Section 25.283(c) concerning venting excess propellant and relieving pressure vessels at end of life. XM-4 is a Boeing 702 model spacecraft. As described in more detail in the attached Technical Appendix, the Boeing 702 has four tanks that retain residual pressure at end of life: two helium tanks sealed following completion of the launch phase, and two tanks containing xenon propellant that cannot be fully vented at end of life. Given the spacecraft design, it is physically impossible for XM Radio to vent these four tanks in order to comply with Section 25.283(c).

Under Commission precedent, grant of a waiver here is clearly appropriate. In a number of recent cases involving both Boeing 702 satellites and other models, the Commission has waived Section 25.283(c) to permit launch and operation of spacecraft that do not allow for full venting of pressure vessels at end of life, based on a finding that modification of the space station design at a late stage of construction would pose an undue hardship.[13] XM Radio would

[13] *See, e.g., DIRECTV Enterprises LLC*, File No. SAT-LOA-20090807-00086, Call Sign S2797, grant-stamped Dec. 15, 2009, Attachment at ¶ 4 (granting a partial waiver of Section 25.283(c) for DIRECTV 12, a Boeing 702 model spacecraft, on grounds that requiring modification of

have faced the same hardship if it had been required to alter the design of XM-4 to conform to Section 25.283(c) prior to launch of the spacecraft.

Of course, with XM-4 already in orbit and operational, there is no question of bringing the satellite into compliance with the rule. The Commission has expressly recognized this, holding that a waiver of Section 25.283(c) is justified for in-orbit spacecraft that cannot satisfy the rule's requirements. Specifically, in a recent decision involving the SES Americom AMC-2 satellite, the Commission granted a waiver on its own motion, observing that venting the spacecraft's sealed oxidizer tanks "would require direct retrieval of the satellite, which is not currently possible."[14]

The same practical obstacle is present here. XM-4 is in orbit, and there is nothing XM Radio can do to enable full venting of residual pressure in the helium and xenon tanks. Given this reality, grant of a waiver is clearly warranted – there is no possible public interest benefit in strictly adhering to the terms of a rule when the licensee is incapable of complying with it.

The record also demonstrates that the inability to vent all residual helium and xenon will not compromise safe disposal of the spacecraft. Information from Boeing indicates that the pressure remaining in the tanks will be well below their tolerances, and both the residual

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satellite would present an undue hardship); *PanAmSat Licensee Corp.*, File Nos. SAT-MOD-20070207-00027, SAT-AMD-20070716-00102, Call Sign S2237, grant-stamped Oct. 4, 2007, Attachment at ¶ 7 (granting a partial waiver of Section 25.283(c) for Intelsat 11 on grounds of undue hardship). *See also Hughes Network Systems, LLC,* File Nos. SAT-MOD-20050523-00106 & SAT-AMD-20060306-00025, Call Sign S2663, grant-stamped June 29, 2006 (authorizing launch and operation of SPACEWAY 3, a Boeing 702 model satellite, without a Section 25.283(c) waiver).

[14] *SES Americom, Inc.*, File No. SAT-MOD-20100324-00056, Call Sign S2134, grant-stamped June 21, 2010, Attachment at ¶ 8. As a condition of the waiver grant for AMC-2, the Commission required SES Americom to file information regarding the mass and volume of the residual oxidizer and the volume of the tank. *See id.*

helium and xenon are inert, posing no risk of chemical energy release. Under these circumstances, XM Radio submits that grant of any necessary waiver of Section 25.283(c) is consistent with Commission precedent.

CONCLUSION

For the foregoing reasons, XM Radio hereby respectfully requests that the Commission modify the license for XM-4 to reassign the satellite to 115.25° W.L. and to permit operations there with a +/- 0.1 degree east-west stationkeeping tolerance.

Respectfully submitted,

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TECHNICAL APPENDIX

1. INTRODUCTION

XM Radio submits this technical appendix in support of its application for a modification of the license of the XM-4 SDARS spacecraft. XM Radio seeks assignment of the satellite to 115.25° W.L. instead of 115.0° W.L. and authority to operate with a +/- 0.1 degree east-west stationkeeping tolerance. XM Radio incorporates by reference the technical information previously provided regarding operations of XM-4,[1] and provides here information that is changing as a result of the proposed modification.

2. GAIN CONTOURS

XM Radio is not submitting new contour maps with this application. The proposed shift in orbital location from 115.0° W.L. to 115.25° W.L. will produce no visible change in the gain contours from the maps already on file.

3. LINK BUDGETS AND INTERFERENCE ANALYSIS

There are no satellites within two degrees of the 115.25° W.L. orbital location that operate in either the S-band frequencies XM Radio uses for service links or the X-band frequencies XM Radio uses for feeder links. XM Radio does not share S-band spectrum with other satellite systems other than its affiliate Satellite CD Radio, and the SDARS downlink frequencies are not subject to two degree spacing rules. In the X-band, the signal transmitted from XM Radio's feeder link earth station depends on the characteristics of that station's antenna. At worst, the gain roll-off of that antenna is bounded by 29-25*log(theta), where theta

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[1] The most recent technical information submitted relating to XM-4 is found in File No. SAT-RPL-20040212-00018; granted, *XM Radio Inc.*, 20 FCC Rcd 1620 (Sat. Div. 2005).

is the angle in degrees away from the antenna boresight. Assuming a hypothetical X-band satellite operating at 117° W.L., operation of XM-4 at 115.25° W.L. rather than 115.0° W.L. results in a worst-case interference increase of 1.4 dB [29-25*log(2 deg)]–[29-25*log(1.75 deg)] for the hypothetical satellite operating at 117.0° W.L. In this scenario, the XM-4 earth station antenna boresight is repointed 0.25 degrees westward from where its boresight would be pointed if XM-4 was at 115.0° W.L.

Given that the proposed offset operation of XM-4 will not result in any material change to the interference environment with respect to XM-4 and existing or future adjacent satellites, no link budget analysis is provided herein. In the unlikely event that any future concerns arise concerning operations of XM-4 at the proposed offset location, XM Radio will coordinate as necessary with the adjacent operators in order to arrive at a mutually satisfactory solution.

4. UPDATED ORBITAL DEBRIS MITIGATION STATEMENT

Pursuant to Section 25.114(d)(14) of the Commission's rules, XM Radio hereby submits the following supplemented information regarding orbital debris mitigation:

Spacecraft Hardware Design **(47 C.F.R. § 25.114(d)(14)(i)).** XM Radio has assessed and limited the amount of debris released in a planned manner during normal operations of XM-4. XM-4 will not be a source of debris during operating mode, as XM Radio does not intend to release debris during normal on-station operations, and the spacecraft will be in a stable configuration. XM Radio has requested authority to operate within a +/- 0.1 degree east-west control box.

XM Radio has assessed and limited the probability of XM-4 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 design of XM-4 locates all critical

spacecraft components within the body of the structure, which provides protection from small orbital debris, and XM Radio has ensured that satellite subsystems have redundant components. The command receivers and decoders, telemetry encoders and transmitters, the bus control electronics, and the power subsystem components are fully redundant, physically separated, and located within a shielded area to minimize the possibility of the spacecraft becoming a source of debris due to a collision.

***Minimizing Accidental Explosions* (47 C.F.R. § 25.114(d)(14)(ii))**. XM Radio has assessed and limited the possibility of accidental explosions during and after completion of mission operations. XM-4 has been designed to minimize the potential for accidental explosions through propellant leakage and fuel and oxidizer mixing or other means. Propellant tanks and thrusters are isolated using redundant valves, and electrical power systems are shielded in accordance with standard industry practices. During the mission, batteries and various critical areas of the propulsion subsystem are monitored to avoid conditions that could result in explosion.

After XM-4 reaches its final disposal orbit, its batteries will be discharged, on-board sources of stored energy will be depleted, all fuel line valves will be left open, and all active units will be turned off. XM-4 is a Boeing 702 model, and as the Commission is aware, four vessels on the spacecraft will retain residual pressure at the satellite's end of life.[2] Two of the vessels contain helium used to maintain pressure in the propellant tanks during launch. At the

[2] *See, e.g.*, Hughes Network Systems, LLC, Amendment to Application for Spaceway 3 Satellite, File No. SAT-AMD-20060306-00025, Call Sign S2663, Narrative at 20-22 (describing characteristics of SPACEWAY 3, a Boeing 702 model spacecraft, and its inability to vent residual helium and xenon at end of spacecraft life), grant-stamped June 29, 2006; DIRECTV Enterprises LLC, Application for Authorization to Launch and Operate DIRECTV 12, File No. SAT-LOA-20090807-00086, Call Sign S2797, Narrative at 19-21 (helium and xenon tanks on DIRECTV 12, a Boeing 702 model spacecraft, will retain residual pressure at end of life), grant-stamped Dec. 15, 2009.

end of the launch phase, these tanks were permanently sealed in order to prevent fuel and oxidizer from bleeding back into the lines where they could mix and create the risk of explosion. Boeing has estimated that each helium tank, which has a volume of 0.068 m^3, will contain residual helium at end of life with a mass of approximately 432 grams and a volume of 0.068 m^3.

The other two vessels contain xenon propellant for the satellite's XIPS drives, which are used for deorbit maneuvers. These tanks are equipped with a regulator, and once the pressure drops below the set point of the regulator, no more gas flows out of the tanks. Boeing estimates that at end of life, each xenon tank, which has a volume of 0.068 m^3, will contain residual xenon with a mass of approximately 1.450 grams and a volume of 0.068 m^3.

Both the residual helium and the residual xenon are inert, posing no risk of chemical energy release. Furthermore, the tanks are well shielded, and the residual pressure in the tanks will be well below their maximum rating. In the narrative portion of this application, XM Radio requests any necessary waiver of Section 25.283(c) in connection with the residual helium and xenon that will remain in these tanks at the end of the satellite's life.

***Safe Flight Profiles* (47 C.F.R. § 25.114(d)(14)(iii))**. XM Radio has assessed and limited the possibility of XM-4 becoming a source of debris by collisions with large debris or other operational space stations. Specifically, XM Radio has assessed the possibility of collision with satellites located at, or reasonably expected to be located at, the requested orbital locations or assigned in the vicinity of those locations.

The underlying application requests reassignment of XM-4 to 115.25° W.L. with a +/- 0.1 degree east-west stationkeeping tolerance to permit operation of XM-4 in formation with XM-1 and XM-2. XM Radio is not aware of any other FCC- or non-FCC licensed spacecraft

that are operational or planned to be deployed at 115.25° W.L. or to nearby orbital locations such that there would be an overlap with the proposed stationkeeping volume of XM-4.

During relocation, the moving spacecraft is maneuvered such that it is at least 10 km away from any nearby satellites when the drift begins or ends and at least 30 km away from the synchronous radius when the planned drift rate is achieved. Advance notification is given to any other operators through whose stationkeeping volumes the spacecraft will pass. When de-orbit of a spacecraft is required, the initial phase is treated as a satellite move, and the same precautions are used to ensure collision avoidance.

Post-Mission Disposal **(47 C.F.R. § 25.114(d)(14)(iv))**. Post-mission disposal of XM-4 from operational orbit will be accomplished by carrying out maneuvers to a higher orbit. Disposal orbit calculations are provided below.

XM-4 was launched after March 18, 2002 and therefore is subject to the minimum perigee requirement of Section 25.283(a) of the Commission's Rules. XM Radio plans to raise XM-4 to a disposal orbit with a minimum perigee altitude 349 km above the GSO operational orbit, or 36,135 km. Based on the expected mass of the satellite at end of life and the required delta-velocity to achieve the desired orbit, XM Radio has determined that 1.39 kg of xenon propellant will be required to reach the planned disposal orbit and plans to reserve that amount. XM Radio has assessed fuel gauging uncertainties and concluded that sufficient xenon propellant reserve will be available, with margin, accounting for fuel gauging uncertainty and other uncertainties.

The disposal orbit calculations for XM-4 are as follows:

Total Solar Pressure Area "A" = 210 m^2
"M" = Dry Mass of Satellite = 2763 kg
"C_R" = Solar Pressure Radiation Coefficient = 1.5

Therefore the Minimum Disposal Orbit Perigee Altitude:
= 36,021 km + 1000 x C_R x A/M
= 36,021 km + 1000 x 1.5 x 210/2763
= 36,135 km
= 349 km above GSO (35,786 km)

5. SCHEDULE S

As discussed above, the proposed modification of the XM-4 license to offset the satellite by 0.25 degrees from 115° W.L. will not result in any material changes to the spacecraft's operating characteristics or to the interference environment. As a result, the information requested in Schedule S duplicates information that is already on file with the Commission concerning the technical parameters of XM-4's operation. In similar cases involving requests for slight offsets from the nominal orbital position, the Satellite Division has not required the submission of a new Schedule S.[3] Accordingly, XM Radio is not filing a Schedule S with this application. XM Radio will nevertheless prepare and submit a Schedule S if requested to do so by the Satellite Division.

[3] *See, e.g.*, File No. SAT-MOD-20040405-00076 (PanAmSat request for authority to operate SBS-6 at 74.05° W.L. rather than 74.0° W.L.).

Technical Certification

I, Bridget Neville, Vice President and General Manager for Satellite Engineering and Operations of XM Radio Inc., hereby certify under penalty of perjury that:

I am the technically qualified person with overall responsibility for preparation of the technical information contained in this application. I am familiar with the technical requirements of Part 25 of the Commission's rules, and the information contained in the application is complete and accurate to the best of my knowledge, information and belief.

/s/
Bridget Neville

Dated: July 22, 2010