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

In the Matter of	)	
	)	
Sirius XM Radio Inc.	)	
	)	
Application for Authority to Launch and Operate SDARS Replacement Spacecraft at 85.15° W.L.	)	File No. SAT-RPL-_____
	)	
Application for Authority to Launch and Operate SDARS Replacement Spacecraft at 115.25° W.L.	)	File No. SAT-RPL-_____

APPLICATION OF SIRIUS XM RADIO INC.

Sirius XM Radio Inc. ("Sirius XM") hereby applies for authority under the Communications Act of 1934, as amended, and the Federal Communications Commission's regulations thereunder, to launch, test, and operate two technically identical satellite digital audio radio service ("SDARS") replacement satellites, designated SXM-7 and SXM-8. Specifically, Sirius XM requests: (1) authority to launch and operate SXM-7, which is intended to replace XM-3 at 85.15° W.L. +/- 0.1 degrees; (2) authority to launch and operate SXM-8, which is intended to replace XM-4 at 115.25° W.L. +/- 0.1 degrees; (3) authority to perform in-orbit testing ("IOT") of each satellite at 120° W.L. +/- 0.1 degrees; (4) authority to perform telemetry, tracking and command ("TT&C") in order to position each satellite at 120° W.L. during IOT and thereafter drift each satellite to its assigned orbital location; and (5) the flexibility to subsequently reposition and operate SXM-7 and SXM-8 at either of the 85.15° W.L. and 115.25° W.L. orbital locations as needed to meet SDARS service requirements. Granting this application will serve the public interest by facilitating Sirius XM's ability to provide continuous, reliable service to tens of millions of SDARS subscribers and other users.

Pursuant to Section 25.114 of the Commission's rules, Sirius XM is attaching a technical narrative that describes the SXM-7 and SXM-8 spacecraft. In addition, a completed FCC Form 312 and a location-specific Schedule S is attached for each satellite.

I. BACKGROUND

Sirius XM provides a full range of audio programming, including music, news, sports, weather, and traffic, to more than 33 million U.S. customers. This content is transmitted to users over a fleet of geostationary orbit ("GSO") spacecraft at four orbital locations: XM-3 at 85.15° W.L., FM-5 at 86.15° W.L., XM-4 at 115.25° W.L., and FM-6 at 116.15° W.L. Back-up capacity for these four primary space stations is provided by the XM-5 in-orbit spare satellite, which flies in formation with XM-3 at 85.15° W.L.

In order to ensure continuity of service to its customers, Sirius XM has entered into contracts to build and launch two next-generation satellites, SXM-7 and SXM-8. Sirius XM proposes to operate SXM-7 at 85.15° W.L. and SXM-8 at 115.25° W.L., but the two satellites are technically identical and each is capable of operating at either of these orbital locations. Sirius XM currently plans to launch SXM-7 in late 2019, with operations commencing in the first quarter of 2020, and plans to launch SXM-8 and commence operations in mid-2020. Prior to commencing operations, each satellite will undergo IOT at 120° W.L., which will allow Sirius XM to verify the performance characteristics of the spacecraft prior to deployment.

The SXM-7 and SXM-8 satellites have downlink frequencies in the 2320-2345 MHz SDARS band and will receive uplink transmissions in the 7025-7075 MHz band designated for SDARS feeder links. In addition to their SDARS payloads, each satellite is equipped with a test beam payload with coverage of a limited area not within Sirius XM's SDARS service area. This beam will use the same frequencies in the 2320-2345 MHz and 7025-7075 MHz bands and will

allow Sirius XM to test new waveforms and ground user terminals without disrupting the SDARS operations. Sirius XM does not plan to activate the test beam at 85.15° W.L.; accordingly, operating authority for the test beam payload is sought only at 115.25° W.L.

During normal operations, TT&C will also be performed in the SDARS frequency bands. However, Sirius XM seeks authority to perform TT&C during initial orbit raising for the satellites using C-band frequencies: 4196-4198.5 MHz (Space-to-Earth) and 6422-6425 MHz (Earth-to-Space). As discussed below, this limited use of C-band spectrum for TT&C will help ensure safe operation of the satellites prior to placement at their assigned locations.

The primary mission for the SXM-7 and SXM-8 satellites is to serve as replacements for the XM-3 and XM-4 spacecraft at 85.15° W.L. and 115.25° W.L., respectively, but the satellites may also be used to provide back-up capacity for other satellites in the Sirius XM fleet. Ensuring robust, continuous SDARS service may require Sirius XM in the future to relocate SXM-7 or SXM-8 from its primary assigned orbital location, moving SXM-7 to 115.25° W.L. or SXM-8 to 85.15° W.L. Sirius XM requests herein the authority to perform such relocations without the need for a prior modification application.

II. AUTHORIZING SXM-7 AND SXM-8 WILL SERVE THE PUBLIC INTEREST AND IS CONSISTENT WITH COMMISSION PRECEDENT

Grant of the requested authority for Sirius XM to launch, test, operate, and relocate SXM-7 and SXM-8 will serve the public interest by enabling Sirius XM to provide service continuity and is fully consistent with Commission precedent.

The Commission has repeatedly recognized that satellite radio offers enormous public interest benefits for the American public.[1] The Commission has observed that satellite radio is unique in its ability to provide nationwide programming, including to the most rural and remote parts of the country that are often underserved by terrestrial radio.[2] Moreover, the Commission has concluded that satellite radio can offer niche programming to listeners with special interests.[3]

Sirius XM now provides high-quality, continuous digital multi-channel audio service to more than 33 million subscribers, from downtown urban cores to rural and remote parts of the United States, serving multiple niche programming interests. SDARS signals also play a critical public safety role during natural disasters and emergencies when terrestrial communications networks may be unavailable. Specifically, Sirius XM uses its network to disseminate emergency alerts and to make available critical weather information, not just to subscribers, but to over 100 million SDARS receivers. By launching and operating next-generation satellites, Sirius XM will ensure its ability to continue providing these and other important services.

---

[1] *See, e.g.*, *Establishment of Rules and Policies for the Digital Audio Radio Satellite Service*, Report and Order, Memorandum Opinion and Order, and Further Notice of Proposed Rulemaking, 12 FCC Rcd 5754 (1997) at ¶ 1.

[2] *Id.* at ¶ 12 ("It is our view that satellite DARS will particularly benefit communities where terrestrial broadcast service is less abundant. The record shows that counties with smaller populations have fewer radio stations and that smaller markets have fewer radio formats.") (footnote omitted); ¶ 13 ("With its national reach, satellite DARS could provide continuous radio service to the long-distance motoring public [and] persons living in remote areas") (footnote omitted); ¶ 90 ("applicants have proposed new choices in audio programming which may be beneficial for the mobile public and for unserved and underserved communities, particularly in rural or remote areas.").

[3] *Id.* at ¶ 14 ("Satellite DARS may also be able to foster niche programming because it can aggregate small, nationally dispersed listener groups that local radio could not profitably serve.") (footnote omitted).

The Commission has expressly recognized a replacement expectancy for GSO satellite operators:

> Given the huge costs of building and operating GSO space stations, we have found that there should be some assurance that operators will be able to continue to serve their customers. Therefore, the Commission has stated that, when an orbit location remains available for a U.S. satellite with the technical characteristics of the proposed replacement satellite, it will generally authorize the replacement satellite at the same location.[4]

The Commission has also made clear that a replacement satellite need not be identical to the current spacecraft:

> We do not require replacement satellites to be technically *identical* to the existing satellite. We recognize that next-generation satellites will incorporate satellites with technical advancements made since the previous generation satellite was launched. We do not intend to change this policy, which facilitates state-of-the-art systems. Rather, we will continue to assess only whether operations of the replacement satellite will be consistent with our international coordination obligations pursuant to regulations promulgated by the International Telecommunication Union.[5]

As discussed above, XM-3 currently operates in the SDARS frequencies at 85.15° W.L., and XM-4 operates in the SDARS frequencies at 115.25° W.L., giving Sirius XM a replacement expectancy for SDARS operations at these orbital locations. The frequencies remain available for use by Sirius XM, and operation of SXM-7 and SXM-8 will conform to the Commission's international coordination obligations. Deploying SXM-7 and SXM-8 as requested herein will

---

[4] *Amendment of the Commission's Space Station Licensing Rules and Policies*, First Report and Order and Further Notice of Proposed Rulemaking, 18 FCC Rcd 10760, 10854-55 (2003) (footnotes omitted). More recently, the Commission codified its processing policy with respect to replacement satellites in Section 25.158(a)(2), which exempts replacement spacecraft from the filing queue otherwise applicable to new space station applications.

[5] *See id.* at 10857 (emphasis in original; footnotes omitted).

allow Sirius XM to use state-of-the-art satellites to ensure long-term continuity of service for SDARS customers. This is exactly what the Commission's long-standing replacement expectancy policy is designed to promote.

Sirius XM's request for authority to test SXM-7 and SXM-8 at 120° W.L. will enable verification of the satellites' operating capabilities without disrupting existing services being provided from the nominal 85º W.L. and 115° W.L. orbital locations. The proposed testing will not cause harmful interference to the operations of any other spacecraft. Sirius XM does not share S-band spectrum with other satellite systems, and no satellites use either S-band or X-band frequencies within two degrees of 120° W.L.

Allowing Sirius XM to position the SXM-7 and SXM-8 satellites at either of the two requested orbital locations, 85.15° W.L. and 115.25° W.L., will also serve the public interest. This flexibility will enhance Sirius XM's ability to deploy its satellite assets as needed to ensure service continuity. Moreover, because the two spacecraft are technically identical, the operating parameters at each orbital location will be the same, regardless of which satellite is positioned at either location.

III. THE COMMISSION SHOULD GRANT ANY NECESSARY RULE WAIVERS FOR SXM-7 AND SXM-8

Sirius XM seeks limited waivers of the Commission's rules in connection with this application for the SXM-7 and SXM-8 replacement satellites. Granting these requested waivers is consistent with Commission policy:

> 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.[6]

SXM-7 and SXM-8 substantially comply with the Commission's rules, but certain waivers are appropriate given the scope of the authority requested, the frequencies to be used, and the planned spacecraft operating parameters. Because SXM-7 and SXM-8 will allow Sirius XM to continue to provide high-quality SDARS programming to tens of millions of users, granting the requested waivers will serve the public interest.

Section 25.118(e): Sirius XM requests any necessary waiver of Section 25.118(e) to allow the SXM-7 and SXM-8 satellites to be relocated as necessary and operated at either 85.15° W.L. or 115.25° W.L. Grant of such a waiver is consistent with the purpose of this rule, which is to facilitate the relocation of satellites among orbital locations assigned to a licensee, provided that such moves do not increase the satellites' interference potential.[7]

Under the Section 25.118(e) framework, a geostationary satellite operator may reposition satellites without prior Commission approval subject to specified requirements, including providing 30 days' notice and submitting certain certifications. Specifically, the rule states in pertinent part that:

> (e) *Relocation of GSO space stations.* A space station licensee may relocate a GSO space station without prior authorization, but upon 30 days prior notice to the Commission and any potentially affected licensed spectrum user, provided that the operator meets the following requirements. The notification must be filed electronically on FCC Form 312 through the International Bureau Filing System (IBFS) in accordance with the applicable provisions of part 1, subpart Y of this chapter:
>
> > (1) The space station will be relocated to a position within ±0.15° of an orbital location assigned to the same licensee.

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

[7] *Amendment of the Commission's Space Station Licensing Rules and Policies,* Second Report and Order, 18 FCC Rcd 12507 (2003) ("Second Space Station Reform Order") at 12509, ¶ 7.

> (2) The licensee certifies that the space station will operate after the relocation within the technical parameters authorized and coordinated for the space station previously assigned to that location.
>
> (3) The licensee certifies that it will comply with all the conditions of its license for operation at the changed location.
>
> (4) The licensee certifies that it will limit operations of the space station to tracking, telemetry, and command functions during the relocation and satellite drift transition period.
>
> (5) The licensee certifies that:
>
> > (i) It has assessed and limited the probability of the satellite becoming a source of debris as a result of collisions with large debris or other operational satellites at the new orbital location; and
> >
> > (ii) The proposed station-keeping volume of the satellite following relocation will not overlap a station-keeping volume reasonably expected to be occupied by any other satellite, including those authorized by the Commission, applied for and pending before the Commission, or otherwise the subject of an ITU filing and either in orbit or progressing towards launch.
>
> (6) The licensee certifies that the relocation will not result in a lapse of service for any current customer.[8]

Consistent with subsections (1), (2), and (3) of the Section 25.118(e), Sirius XM is seeking authority to position the SXM-7 and SXM-8 satellites at either of two orbital locations assigned to it, subject to all the technical parameters and license terms and conditions associated with each orbital position. Because the satellites are technically identical, the operating characteristics at the two locations will be the same without regard to whether the spacecraft operating at a given orbital slot is SXM-7 or SXM-8. The requirements in subsection (5) of the rule are met as well: the orbital debris mitigation showing provided in the technical appendix to this application is not dependent on the specific orbital location at which SXM-7 or SXM-8 is

[8] 47 C.F.R. § 25.118(e). The final two provisions of the rule, subsections (7) and (8), are limited to DBS spacecraft, and thus are not applicable to the SDARS satellites at issue here.

operating, and any overlap of the stationkeeping volume at either orbital slot would involve only other satellites operated by Sirius XM. Moreover, Sirius XM would reposition SXM-7 or SXM-8 solely to ensure service continuity, consistent with the mandate of subsection (6) of the rule.

The authority Sirius XM requests requires waiving the provisions of Section 25.118(e) in two respects. First, rather than providing 30 days' notice to the Commission prior to any relocation of SXM-7 or SXM-8, Sirius XM seeks advance authority to reposition either satellite subject only to a requirement to notify the Commission within two business days after commencing a move. Second, Sirius XM requests a waiver of subsection (4) of the rule to allow SDARS operations, not just TT&C functions, during any satellite relocation.

Departure from the Commission's typical requirements is justified under the specific circumstances here. As noted above, Sirius XM is the sole licensee in the SDARS frequency bands, having purchased the spectrum at auction, and the 85.15° W.L. and 115.25° W.L. orbital locations are both already assigned to Sirius XM. As a result, repositioning SXM-7 or SXM-8 between these two orbital locations, and operating the satellite's SDARS payload during the drift, would not create interference issues affecting other satellite operators.

Affording Sirius XM the requested flexibility is fully consistent with the purpose underlying the Section 25.118(e) fleet management provision. In adopting the rule, the Commission observed that:

> Establishing a streamlined procedure for satellite fleet management modifications . . . would expedite grant of modification applications that do not involve increased interference potential. We have previously allowed satellite operators to rearrange satellites in their fleet to reflect business and customer considerations where no other public interest factors are adversely affected. Moreover, such a streamlined procedure would facilitate satellite operators' efforts to meet the service needs of their customers. Further, by devoting fewer administrative

> resources to satellite fleet management modification requests, we can direct more attention to other pending applications.[9]

Granting the requested repositioning flexibility for SXM-7 and SXM-8 will promote these goals by allowing Sirius XM to manage its spacecraft as needed to facilitate service continuity for SDARS subscribers, while minimizing unnecessary administrative burdens on the Commission and its staff. Because no other party is authorized to use SDARS spectrum, enforcing the full requirements in Section 25.118(e), including the advance notification obligation and the restriction to TT&C operations during drift, is not needed to prevent interference. Moreover, the Commission has previously authorized SDARS operations during satellite drift to enable the provision of uninterrupted service, allowing FM-5's communications payload to remain active as the satellite was relocated from 96° W.L. to 86.15° W.L.[10]

The authority Sirius XM seeks to reposition SXM-7 or SXM-8 is fully consistent with the purpose of Section 25.118(e), with the public interest in continuity of SDARS service, and with Commission precedent. Accordingly, the Commission should grant limited waivers of the Section 25.118(e) requirements to allow Sirius XM the flexibility to redeploy its satellites as needed between the 85.15° W.L. and 115.25° W.L. orbital locations and to provide SDARS service during any such relocations.

Section 25.202(g): Sirius XM requests any necessary waiver of the requirements of Section 25.202(g) of the Commission's rules relating to performing telemetry, tracking and

[9] Second Space Station Reform Order, 18 FCC Rcd at 12509-12510, ¶ 7 (footnotes omitted).

[10] *See Sirius XM Radio Inc.*, Call Sign S2710, File No. SAT-MOD-20151211-00081, granted Feb. 25, 2016. *See also XM Radio, Inc.*, Call Sign S2616, File No. SAT-MOD-20100722-00165, granted Oct. 14, 2010 (authorizing SDARS operations during drift of XM-4 satellite from 115° W.L. to 115.25° W.L.).

command ("TT&C") within the bands assigned for satellite operations.[11] The Commission has explained that:

> The purpose of this rule is to simplify the coordination process for satellite systems, to provide an incentive for an operator to maximize the efficiency of its system's TT&C operations, and to minimize the constraints placed on other satellite operations.[12]

Here, Sirius XM is seeking to use specific frequencies at the edges of the conventional C-band spectrum for a limited time during the orbit-raising stage following launch of SXM-7 and SXM-8. During that phase, when the satellites circumnavigate the globe, Sirius XM needs to be able to reliably send commands and receive telemetry signals in order to ensure the safe transit of the spacecraft.

Prior geostationary Sirius XM satellites relied for TT&C solely on S-band SDARS downlink spectrum at 2320-2345 MHz and uplink spectrum at 7025-7075 MHz. However, Sirius XM experienced significant interference from S-band terrestrial systems during orbit raising of previous satellites, putting them at risk by impairing Sirius XM's ability to reliably receive telemetry information regarding the satellites' position. During the years following Sirius XM's most recent satellite launch in 2013, deployment of terrestrial systems using S-band spectrum has increased, potentially exacerbating interference issues for future launches. Sirius XM seeks to avoid similar interference events by employing conventional C-band spectrum for TT&C during this phase.

Granting this waiver will not undermine the rule's objectives, which include facilitating coordination, avoiding undue constraints on other satellite operations, and ensuring efficient use

[11] 47 C.F.R. § 25.202(g).

[12] *Orbcomm License Corp*., 23 FCC Rcd 4804 at ¶ 20 (IB & OET 2008).

of spectrum for TT&C. No other party will be harmed by the limited C-band operations. Consistent with industry practice, all TT&C operations during orbit-raising will be coordinated with satellites that use the same frequency bands and are in the orbit-raising path. U.S. earth stations supporting the orbit-raising maneuvers will need to obtain special temporary authority ("STA") from the Commission, and any such STA grant will authorize operations that will be unprotected and may not cause harmful interference.

Grant of a waiver will also serve the public interest. Using conventional C-band spectrum during the brief but critical orbit-raising phase will improve the reliability of the telemetry data received. Moreover, the requested C-band use will greatly increase the number of earth stations around the globe capable of supporting the orbit-raising process.

The Commission has previously waived Section 25.202(g) to allow use of TT&C frequencies outside a satellite's service bands based on similar considerations involving international frequency usage and earth station availability. For example, the Commission authorized the use of C-band TT&C spectrum in connection with the legacy Sirius non-geostationary SDARS fleet based on a finding that using C-band frequencies would avoid potential interference issues involving terrestrial services outside the U.S.[13] The Commission has also waived Section 25.202(g) for transfer orbit operations given the unavailability of service-band earth station facilities around the globe.[14] Grant of a waiver to permit C-band

[13] *Sirius Satellite Radio Inc.*, 16 FCC Rcd 5419, 5425 at ¶ 15 (IB 2001) (waiving Section 25.202(g) to allow C-band TT&C "will prevent interference to terrestrial systems in the Southern Hemisphere thereby decreasing the coordination difficulties with countries in the region").

[14] *See, e.g., DIRECTV Enterprises, LLC*, 21 FCC Rcd 8028, 8035 at ¶ 14 (Sat. Div. 2006) (the lack of available DBS-band TT&C facilities around the world constitutes special circumstances "that warrant a deviation from Section 25.202(g) for the limited purpose of short-term transfer orbit TT&C operations").

TT&C for SXM-7 and SXM-8 during transfer orbit maneuvers is fully consistent with this precedent.

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."[15] Sirius XM seeks authority for an expanded stationkeeping volume to facilitate flying SXM-7 and SXM-8 in formation with other spacecraft at the 85.15° W.L. and 115.25° W.L. orbital locations. Specifically, at the satellites' initially authorized orbital locations, SXM-7 will be collocated with XM-5 and XM-3 until such time as the latter satellite is relocated or retired, and SXM-8 will be collocated with XM-4 until such time as that satellite is relocated or retired. Sirius XM also proposes to maintain SXM-7 and SXM-8 with a +/- 0.1 degree stationkeeping tolerance at 120° W.L. during IOT in order to minimize interruptions to the payload testing operations due to stationkeeping maneuvers.

The Commission has previously waived this rule 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."[16] In addition, the Commission has waived the rule to allow operating multiple space stations in formation within a combined stationkeeping volume.[17]

---

[15] 47 C.F.R. § 25.210(j).

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

[17] *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.").

The facts here fit squarely within this precedent. Allowing SXM-7 and SXM-8 to operate within an increased stationkeeping volume will not harm other operators. The only satellites with which SXM-7's or SXM-8's stationkeeping volume will overlap are other spacecraft in Sirius XM's own fleet. Sirius XM will ensure that each of its satellites' flight is closely controlled to ensure the fleet's safe joint operation. Furthermore, the proposed operations will not materially affect the interference environment.

Finally, allowing SXM-7 and SXM-8 to be flown in formation with other satellites in an east-west stationkeeping volume of +/-0.1 degree facilitates in-orbit sparing for all of the Sirius XM spacecraft at the 85.15° W.L. and 115.25° W.L. orbital locations by allowing faster service restoral on a backup satellite in the event of an issue on the primary satellite. Under these circumstances, grant of any necessary waiver of Section 25.210(j) will serve the public interest.

IV. WAIVER PURSUANT TO SECTION 304 OF THE ACT

In accordance with Section 304 of the Communications Act of 1934, as amended, 47 U.S.C. §304, Sirius XM hereby waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise.

V. CONCLUSION

For the foregoing reasons, Sirius XM hereby respectfully requests that the Commission promptly grant this Application to authorize the launch, operation, testing, and relocation of the SXM-7 and SXM-8 replacement satellites as described herein, allowing Sirius XM to continue to provide to the public the significant benefits of high-quality, reliable SDARS service.

Respectfully submitted,

Sirius XM Radio Inc.

Of Counsel:
Karis A. Hastings
SatCom Law LLC
1317 F Street, N.W., Suite 400
Washington, D.C. 20004

/s/ James S. Blitz
James S. Blitz
Vice President, Regulatory Counsel
1500 Eckington Place, N.E.
Washington, D.C. 20002

April 30, 2018

ATTACHMENT A

TECHNICAL DESCRIPTION OF SXM-7 AND SXM-8

A.1 GENERAL DESCRIPTION (Section 25.114(d)(1))

Sirius XM Radio Inc. (Sirius XM) and its affiliates XM Radio Inc. (XM Radio) and Satellite CD Radio LLC (Satellite CD) currently operate a network of geostationary Satellite Digital Audio Radio Service (SDARS) satellites, including XM-3 at 85.15°W.L., FM-5 at 86.15°W.L., XM-4 at 115.25°W.L., and FM-6 at 116.15°W.L. In addition, the XM-5 satellite, which is collocated with XM-3 at 85.15°W.L., serves as an in-orbit spare to provide backup capacity for FM-5, FM-6, XM-3 and XM-4 in the event of an outage on any of those spacecraft. This network of satellites provides SDARS in the 2320-2345 MHz band (Space-to-Earth) and receives uplink transmissions in the 7025-7075 MHz band (Earth-to-Space).

Sirius XM is seeking authority to launch and operate two additional satellites, SXM-7 and SXM-8. SXM-7 will serve as a replacement satellite for XM-3 and as a potential backup satellite for FM-5 and FM-6. SXM-7 will be positioned at 85.15°W.L. ± 0.1 degrees, where it will be operated in formation with XM-5 and with XM-3 until that satellite is retired or relocated. SXM-8 will serve as the replacement satellite for XM-4 and also as a potential backup satellite for FM-5 and FM-6. SXM-8 will be positioned at 115.25°W.L. ± 0.1 degrees, where it will be operated in formation with XM-4 until that satellite is retired or relocated. Following launch, Sirius XM will temporarily position each satellite at 120°W.L. for in-orbit testing to confirm spacecraft operating parameters before moving the satellite to its intended orbital position.

SXM-7 and SXM-8 are identical satellites with the exception of the unique TT&C frequencies described in Table A.3-1, and both satellites can operate at either 85.15°W.L or 115.25°W.L. As further explained in the legal narrative portion of this application, Sirius XM seeks the flexibility to position SXM-7 and SXM-8 at either of these two orbital locations as needed to meet SDARS service requirements. A location-specific Schedule S is being submitted for each satellite,

reflecting the intended operation of SXM-7 at 85.15°W.L. ± 0.1 degrees and the intended operation of SXM-8 at 115.25°W.L. ± 0.1 degrees.

The SXM-7 and SXM-8 satellites will provide SDARS broadcast service to receiving terminals located in the contiguous United States (CONUS), Puerto Rico, and Canada. Each of the satellites will also be capable of providing broadcast service to a limited coverage area outside the SDARS service area to enable testing of new waveforms and ground user terminals utilizing a test beam payload. Sirius XM will activate the test beam payload only at the 115.25°W.L. orbital location.

The SXM-7 and SXM-8 satellites will be capable of operating across the full range of frequencies used by the existing SDARS fleet, 2320-2345 MHz (Space-to-Earth) and 7025-7075 MHz band (Earth-to-Space). TT&C operations for orbit raising will take place in C-band frequencies, 4196.0-4198.5 MHz (Space-to-Earth) and 6422.0-6425.0 MHz (Earth-to-Space), as discussed in detail in Section A.3. Once the SXM-7 and SXM-8 satellites reach their assigned orbital locations, on-station and contingency TT&C operations will take place within the SDARS and feeder link frequency ranges.

A.2 **SCHEDULE S**

Section 25.114(c)(4)(ii)

The SDARS communication payload beam SD1 has a maximum transmit EIRP density of 7.5 dBW/Hz, which exceeds the maximum of 0.0 dBW/Hz allowed by Schedule S. As a result, a value of -7.5 dBW/Hz has been entered in Schedule S. The SD1 maximum EIRP occurs when the satellite is operated with a 4.5 MHz transmission bandwidth. However, the maximum transmit EIRP density of 7.5 dBW/Hz occurs when the satellite is operated at a reduced EIRP over a narrower transmission bandwidth of 1.84 MHz.

Section 25.114(c)(4)(vi)(A)

Pursuant to Section 25.114(c)(4)(vi)(A), the gxt diagrams for the global telecommand receive beam (OSC1), Omni telecommand receive beams (OMC1 and OMX1), and Omni telemetry transmit beams (OMC2 and OMS1) are not included because for each of these beams the contour at 8 dB below peak falls entirely beyond the edge of the visible Earth.

Section 25.114(c)(5)(i)

The online Schedule S automatically rounds the orbital location to a whole number, but the requested orbital location for SXM-7 is 85.15°W.L., and the requested orbital location for SXM-8 is 115.25°W.L.

A.3 **TT&C**

The telemetry, tracking, and command (TT&C) subsystem provides the satellite communications links for pre-launch, orbit-raising, and on-station operations.

During orbit raising, TT&C operations will be conducted in frequencies on the edges of the conventional C-band to mitigate interference with terrestrial systems using the assigned S-band frequencies outside of North America. Using S-band for TT&C, Sirius XM experienced significant interference from terrestrial systems during orbit raising of previous satellites, and deployment of terrestrial systems using S-band has only increased since our most recent launch in 2013. Sirius XM will follow standard industry procedures to coordinate use of the C-band frequencies during orbit raising operations. The orbit raising TT&C system is a standard C-band system and incorporates redundant command receivers, telemetry transmitters, and power amplifiers, and uses wide angle C-band antennas for command and telemetry.

The on-station and contingency satellite TT&C system is a standard X/S-band system and incorporates redundant command receivers, telemetry transmitters, and power amplifiers. Contingency operations use wide angle X-Band antennas for command and S-band wide angle antennas for telemetry. On-station operations utilize the X-Band global horn for on-station command operation and the S-band broadcast area coverage antenna for telemetry. The TT&C carriers and frequencies are given in Table A.3-1 below.

Table A.3-1: TT&C Carriers and Frequencies

Parameter	Orbit Raising SXM-7 and SXM-8	On-Station and Contingency SXM-7	On-Station and Contingency SXM-8
Command/Ranging Frequencies/Polarization	6422.5 MHz (LHCP) 6424.5. MHz (LHCP)	7041.0 MHz (LHCP) 7073.0 MHz (LHCP)	7049.0 MHz (LHCP) 7073.0 MHz (LHCP)
Telemetry/Ranging Frequencies	4196.5 MHz (RHCP) 4198.0 MHz (RHCP)	2323.1 MHz (RHCP) 2325.5 MHz (RHCP) 2335.0 MHz (RHCP) 2339.6 MHz (RHCP)	2323.8 MHz (RHCP) 2327.0 MHz (RHCP) 2335.7 MHz (RHCP) 2338.9 MHz (RHCP)

A.4 ORBITAL DEBRIS MITIGATION (Section 25.114(d)(14))

Each section below addresses specific measures taken by Sirius XM, as required under Section 25.114(d)(14) of the Commission's rules, to limit the possibility that its space station operations will generate orbital debris.

Spacecraft hardware design: Sirius XM and its satellite contractor have assessed and limited the amount of debris that will be released in a planned manner during normal operations of SXM-7 and SXM-8. During the satellites' ascent, after separation from the launcher, no debris will be generated. All deployments will be conducted using release mechanisms designed to retain all physical debris. No debris will be released by the space stations during normal on-station operations.

Sirius XM has also assessed and limited the probability of the space stations' becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal. The possibility of collisions with the background environment, including meteoroids, is considered as part of the satellite design on a statistical basis to determine collision risk. Sirius XM's satellite manufacturer, SSL, includes meteoroid environments as part of the satellite Environmental Requirement Specifications. Literature was reviewed for large size space objects, particularly technical papers that present collision probability estimates for orbital conditions of interest. The satellite requirement was derived from these technical papers as well as NASA models to include debris and meteoroids of various sizes. Sirius XM has taken steps to limit the

effects of such collisions through shielding, the placement of components, and the use of redundant systems.

Accidental explosions, energy sources on board: Sirius XM has assessed and limited the probability of accidental explosions during and after completion of mission operations. In designing the SXM-7 and SXM-8 satellites, the satellite manufacturer has taken steps to ensure that debris generation will not result from the conversion of energy sources on board the satellite into energy that fragments the satellite. In particular, the satellite manufacturer advises that no structural failures of pressurized volumes have occurred on its satellites to date. Burst tests are performed on all pressure vessels during qualification testing to demonstrate a margin of safety against burst. Bipropellant mixing is prevented by the use of valves that prevent backwards flow in propellant lines and pressurization lines. The Lithium Ion batteries do not contain any pressure vessels, and Sirius XM will undertake procedures to assure that each battery is discharged at the end of the mission. Pyrotechnics are nominally used in the mission only as part of the initial deployment process. After orbit raising to the disposal orbit, all unfired pyrotechnics will be fired as part of the final satellite decommissioning. Upon reaching the final disposal orbit, all fuel tanks will be close to empty. All remaining propellants and pressurants will be vented utilizing the on-board thrusters.

Collisions with large debris or operational space stations: Sirius XM has assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations. Specifically, Sirius XM 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.

SXM-7 will be positioned at 85.15° W.L. and will be flown in formation with XM-5 in an east-west stationkeeping volume of +/- 0.1 degrees. XM-3 will also be collocated at 85.15° W.L. and will serve as a secondary spare until it is retired or relocated.

SXM-8 will be positioned at 115.25°W.L. in an east-west stationkeeping volume of +/- 0.1 degrees. XM-4 will be collocated at 115.25°W.L. and will serve as a spare until it is retired or relocated.

As detailed below, Sirius XM has examined whether its station-keeping volume might overlap with that of other operational or planned satellites at the 85.15° W.L. and 115.25°W.L. orbital locations. In addition, Sirius XM has reviewed networks for which a request for coordination has been published by the ITU within ±0.15 degrees of 85.15° W.L. or 115.25°W.L.

Sirius XM is not aware of any other FCC or non-FCC licensed spacecraft that are operational or planned to be deployed at 85.15°W.L. or to nearby orbital locations such that there would be an overlap with the stationkeeping volume of SXM-7. Moreover, Sirius XM is not aware of any ITU filing for a satellite that is operational or progressing towards launch that is planned to be deployed at the nominal 85°W.L. orbital location such that there would be an overlap with the stationkeeping volume requested for SXM-7. SES Americom currently holds Commission authorization to operate AMC-16 at 85.0° W.L. with an east-west stationkeeping tolerance of +/- 0.05 degrees, so there will be no overlap of its stationkeeping volume with that of SXM-7. Coordination with SES Americom is not required to assure physical separation, but Sirius XM will notify SES Americom of Sirius XM's plans to deploy SXM-7 and exchange emergency control center contact data.

Sirius XM 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 stationkeeping volume of SXM-8. Moreover, Sirius XM is not aware of any ITU filing for a satellite that is operational or progressing towards launch that is planned to be deployed at the nominal 115°W.L. orbital location such that there would be an overlap with the stationkeeping volume requested for SXM-8. ViaSat, Inc. currently holds Commission authorization to operate ViaSat-1 at 115.1° W.L. with an east-west stationkeeping tolerance of +/- 0.05 degrees, so there will be no overlap of its stationkeeping volume with that of SXM-8. Coordination with ViaSat is not required to assure physical separation, but Sirius XM will notify ViaSat of Sirius XM's plans to deploy SXM-8 and exchange emergency control center contact data.

Post-mission disposal: At the end of the operational life of each spacecraft, Sirius XM will maneuver the SXM-7 and SXM-8 satellites into a disposal orbit with a minimum perigee of 325 km above the normal GSO operational orbit. This proposed disposal orbit altitude is based on the following calculation, as required in § 25.283:

Total Solar Pressure Area "A" = 117 m^2

"M" = Dry Mass of Satellite = 2884 kg

"C_R" = Solar Pressure Radiation Coefficient (worst case) = 2

Therefore the Minimum Disposal Orbit Perigee Altitude:

= 36,021 km + 1000 x C_R x A/M

= 36,021 km + 1000 x 2 x 117/2884

= 36,102 km

= 316 km above GSO (35,786 km)

To provide adequate margin, the nominal disposal orbit will be increased above this calculated value of 316 km to a value of 325 km.

The propulsion subsystem design and the SXM-7 and SXM-8 satellite fuel budgets account for the post-mission disposal of the satellites. Sirius XM will reserve approximately 3 kg of xenon for the orbit raising maneuvers. Sirius XM has assessed fuel-gauging uncertainty and has provided an adequate margin of fuel reserve to address the assessed uncertainty.

A.5 **POWER FLUX DENSITY (Section 25.208(a))**

Section 25.208(a) specifies the maximum power flux density (PFD) allowed in the C-band frequencies. The maximum PFD levels for SXM-7 and SXM-8 are provided in the Schedule S and do not exceed the limits set forth in Section 25.208(a).

There are no PFD limits in the 2320-2345 MHz downlink frequency band according to the FCC Rules or the ITU Radio Regulations. However, the United States has entered into international coordination agreements which limit the PFD level from the Sirius XM-owned SDARS satellites into Canada and Mexico.[1] SXM-7 and SXM-8 will operate in compliance with the terms of those agreements.

[1] *See* Letter from Michael Binder, Assistant Deputy Minister, Spectrum, Information Technologies and Telecommunications, Industry Canada, to Ambassador Vonya B. McCann, U.S. Coordinator and Deputy Assistant Secretary, International Communications and Information Policy, U.S. Department of State (August 25, 1998) (attached to Report No. IN 98-50, *News Release* (Sept. 3,

A.6 **CONUS COVERAGE (Section 25.144(a)(3)(i))**

Files showing the antenna gain contours for SXM-7 and SXM-8 are included with the Schedule S. These files demonstrate that the satellites will provide full-CONUS coverage, as required by Section 25.144(a)(3)(i).

A.7 **USER TERMINALS (Section 25.144(a)(3)(ii))**

More than 33 million receivers are currently subscribed to the Sirius XM service, and that figure is expected to be even higher at commencement of SXM-7 and SXM-8 satellite operation. Most of the receivers are installed in vehicles (including automobiles, trucks, and boats). While an interoperable radio capable of receiving signals in both the segment of the SDARS frequency band used by the legacy Sirius-band satellites and the segment used by the legacy XM-band satellites is available, most user terminals in service today can receive signals from only one satellite constellation and not both. A new generation chipset is expected to be available in 2019 and will have full interoperable capability across the entire SDARS frequency band.

1998)): Agreement Between the Government of the United States of America and the Government of the United Mexican States Concerning the Use of the 2310-2360 MHz Band (July 24, 2000).

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 pleading, 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 pleading, and that it is complete and accurate to the best of my knowledge and belief.

/s/ Bridget Neville

Bridget Neville
Senior Vice President, Satellite and
Terrestrial Engineering
Sirius XM Radio Inc.
1221 Avenue of the Americas
New York, NY 10020
(212) 584-5106

Dated: April 30, 2018