ATTACHMENT A

TECHNICAL DESCRIPTION OF SXM-12

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

Sirius XM Radio LLC (Sirius XM) and its affiliates XM Radio LLC (XM Radio) and Satellite CD Radio LLC (Satellite CD) currently operate a network of geostationary Satellite Digital Audio Radio Service (SDARS) satellites, including SXM-7, SXM-8, and SXM-9 at 85.15°W.L., FM-5 at 86.15°W.L., XM-5 and SXM-11 at 115.25°W.L., and SXM-10 at 116.15°W.L. This list includes both satellites currently providing service and others that are maintained in a backup capacity. At the time of this application the FM-6 satellite is in the process of being de-orbited. Collectively, this network of satellites provides SDARS in the 2320-2345 MHz band (Space-to-Earth), as well as providing ancillary services in the WCS C and D Blocks (2315-2320 MHz and 2345-2350) MHz bands. These satellites receive uplink transmissions in the 7025-7075 MHz band (Earth-to-Space).

Sirius XM is seeking authority to launch and operate one additional satellite, SXM-12. SXM-12 will serve as a replacement satellite for FM-5. SXM-12 is intended to be positioned at 86.15°W.L. ± 0.1 degrees where it will be operated in formation with FM-5 until that satellite is retired. Following launch, Sirius XM will temporarily position the SXM-12 satellite at 88.0°W.L. for in-orbit testing to confirm spacecraft operating parameters before moving the satellite to its intended orbital position.

As further explained in the legal narrative portion of this application, Sirius XM seeks the flexibility to position SXM-12 at any of these four orbital locations (85.15°W.L., 86.15°W.L., 115.25°W.L., and 116.15°W) as needed to meet SDARS service requirements. A location-specific Schedule S is being submitted, reflecting the intended operation of SXM-12 at 86.15°W.L. ± 0.1 degrees.

The SXM-12 satellite will provide SDARS broadcast service to receiving terminals located in the contiguous United States (CONUS), Puerto Rico, and Canada. The satellite will also be capable of providing additional broadcast services utilizing a WCS payload beam.

The SXM-12 satellite is also intended to provide digital communications service in the WCS C Block (2315-2320 MHz) and D Block (2345-2350 MHz) spectrum bands. Sirius XM requests authority to transmit in these WCS spectrum bands using the secondary WCS payload or the main beam payloads, depending on operational needs.

The SXM-12 satellite will be capable of operating across the full range of frequencies in SDARS (2320-2345 MHz) and WCS C and D Block (2315-2320 MHz and 2345-2350 MHz) bands. 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. During test and drift phases and once the SXM-12 satellite reaches its assigned orbital location, on-station and contingency TT&C operations will take place within the SDARS, WCS C Block, WCS D Block, and feeder link frequency ranges.

Among other Commission rule requirements as to which SXM-12 will be compliant, Sirius XM notes that its operations will be compliant with Sections 25.202(e) and (f) of the Commission's rules.

A.2 SCHEDULE S

Section 25.114(c)(4)(ii)

The SDARS communication payload beam SD1 has a maximum transmit EIRP density of 7.97 dBW/Hz. The SD1 maximum EIRP occurs when the satellite is operated with a 4.5 MHz transmission bandwidth. However, the maximum transmit EIRP density of 7.97 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 requested orbital location for SXM-12 is 86.15°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 over time. 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 nominal TT&C carriers and frequencies are given in Table A.3-1 below and are identified in the Schedule S. However, the X-band command receivers and the S-band transmitters on the satellites are frequency flexible, allowing them to operate at any frequency in the 7025-7075 and 2315-2350 MHz bands. Sirius XM seeks flexibility to use those full ranges, which will enable Sirius XM to better manage the potential interference between the payload carriers and command carriers for the entire constellation.

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

Parameter	Orbit Raising	Nominal On-Station and Contingency
Command/Ranging Frequencies/Polarization	6422.5 MHz (LHCP) 6424.5. MHz (LHCP)	7037.0 MHz (LHCP) 7047.0 MHz (LHCP)
Telemetry/Ranging Frequencies	4196.5 MHz (RHCP) 4198.0 MHz (RHCP)	2337.7 MHz (RHCP) 2341.0 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-12. During the satellite's 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.

The satellite is equipped with a propulsion system that includes electric and chemical thrusters that allow for satellite maneuverability and can be used to avoid collisions based on conjunction alerts. The satellite will be actively tracked using our licensed tracking stations. The space station will be registered with 18th Space Control Squadron (http://www.space-track.org/) or its successor entity. Upon receipt of a space situational awareness conjunction warning, we will review and take all

possible steps to assess the collision risk and will mitigate the collision risk as necessary. No debris will be released from the space station during normal operations.

Accidental explosions, energy sources on board: Sirius XM has assessed and limited the possibility of accidental explosions during and after completion of mission operations. In designing the SXM-12 satellite, 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-12 will be positioned at 86.15° W.L. and will be flown in formation with FM-5 in an east-west station-keeping volume of +/- 0.1 degrees. FM-5 will also be collocated at 86.15° W.L. and will serve as a secondary 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 on-station orbital locations of 85.15° W.L., 86.15° W.L., 115.25° W.L., and 116.15°W.L. as well as the IOT orbital location of 88.0° W.L. .

In addition, Sirius XM has reviewed networks for which a request for coordination has been published by the ITU within ±0.15 degrees of 86.15°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 86.15°W.L. or to nearby orbital locations such that there would be an overlap with the station-keeping volume of SXM-12. 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 86.15°W.L. orbital location such that there would be an overlap with the stationkeeping volume requested for SXM-12. SES Americom currently holds Commission authorization to operate SES-2 at 87° 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-12. 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-12 and exchange emergency control center contact data.

Collisions with small debris: Sirius XM has also assessed and limited the probability of the space station's 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, Intuitive Machines, 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. As calculated using the NASA Debris Assessment Software, SXM-12's probability of collision with small objects is less than 0.01.

Post-mission disposal: At the end of the operational life of the spacecraft, Sirius XM will maneuver the SXM-12 satellite 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 = 2945 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 117/2945

= 36,100 km

= 314 km above GSO (35,786 km)

To provide adequate margin, the nominal disposal orbit will be increased above this calculated value of 314 km to a value of 325 km.

The propulsion subsystem design and the SXM-12 satellite fuel budget account for the post-mission disposal of the satellite. Sirius XM will reserve approximately 20kg of fuel for orbit raising maneuvers. Sirius XM has assessed fuel-gauging uncertainty and has provided an adequate margin of fuel reserve to address the assessed uncertainty.

Stored energy will be removed at the spacecraft's end of life by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy. The spacecraft does not contain any liquids, ionic or otherwise, that if released either intentionally or unintentionally would persist in droplet form.

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-12 is 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 SDARS (2320-2345 MHz) or WCS C and D Block (2315-2320 MHz and 2345-2350 MHz) downlink frequency bands according to the FCC Rules or the ITU Radio Regulations.

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

Files showing the antenna gain contours for SXM-12 are included with the Schedule S. These files demonstrate that the satellite will provide full-CONUS coverage, as required by Section 25.144(a)(3)(i).

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

Approximately 33 million receivers are currently subscribed to the Sirius XM service. Most of the receivers are installed in vehicles (including automobiles, trucks, and boats).

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*
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