

Before the
Federal Communications Commission
Washington, DC 20554

Application of

Capella Space Corp.

For Authority to Launch
and Operate a Non-Geostationary
Orbit Satellite System in the Earth
Exploration Satellite Service

Call Sign: S3080

File No. _____

**Application for Modification of Authority to Launch and Operate a
Non-Geostationary Orbit Satellite System in the Earth Exploration
Satellite Service**

Capella Space Corp. (“Capella”) hereby requests a limited modification of its existing authorization to launch and operate two small satellites known as Capella-5 and Capella-6.¹ This modification is necessary to account for a change in launch schedule for Capella-5 resulting in altered orbital characteristics. Capella-6 is not affected by this change and Capella requests no modification with respect to that satellite.

Capella’s existing authorization permits Capella-5 to be deployed at an altitude of 575 km and 53° inclination. Due to the change in launch schedule, however, Capella requests a modification to its existing authorization to permit launch and deployment of Capella-5 with the following orbital parameters:

¹ See Grant of Authority, SAT-LOA-20210119-00012 (granted May 4, 2021).

| | |
|---------------------|---------------------------|
| Inclination | $97.5 \pm 3^\circ$ |
| Orbital Period | $5,708 \pm 63$ secs |
| Apogee | 525 ± 25 km |
| Perigee | 525 ± 25 km |
| Argument of Perigee | N/A – Near Circular Orbit |
| Active Service Arc | Full Orbit |
| RAAN | 259 ± 60 min |

Notably, these are virtually identical to the orbital characteristics of Capella-3, which the Commission authorized under a previous Capella space station license.² No other characteristic of Capella-5 will change including its radiofrequency characteristics (frequencies used, radiated power levels, antenna gain, etc.) or any aspect of its hardware design. Authorization of the modified system will allow Capella to offer the services and significant public interest benefits described in its previous application for launch and operating authority under the modified launch schedule.³

A. Launch schedule

The Capella-6 is currently scheduled for launch in May 2021, pursuant to Capella’s existing authorization. Capella-5 is scheduled to launch in June of 2021. Both will be launched on SpaceX Falcon 9 launch vehicles from the continental United States.

² See Grant of Authority, SAT-LOA-20200914-00108 (granted Dec. 17, 2020).

³ See Legal Narrative, SAT-LOA-20210119-00012 at 1, 11-14 (granted May 4, 2021).

I. Small satellite certifications

Consistent with the requirements for streamlined treatment under Section 25.122, Capella hereby certifies that the space stations to be operated under the requested license, as modified, continue to meet the following criteria:

1. The space stations will operate only in non-geostationary orbit.
2. The total in-orbit lifetime for any individual space station will be six years or less.
3. The space stations will be deployed at an orbital altitude of 600 km or below, will maintain a propulsion system, and have the ability to make collision avoidance and deorbit maneuvers using propulsion.⁴
4. Each space station will be identifiable by a unique signal-based telemetry marker distinguishing it from other space stations or space objects.
5. The space stations will release no operational debris.
6. Capella has assessed and limited the probability of accidental explosions, including those resulting from the conversion of energy sources on board the space stations into energy that fragments the spacecraft.
7. The probability of a collision between each space station and any other large object (10 centimeters or larger) during the orbital lifetime of the space station is 0.001 or less as calculated using current NASA software or other higher fidelity model.
8. The space stations will be disposed of post-mission through atmospheric re-entry. The probability of human casualty from portions of the spacecraft surviving re-entry and reaching the surface of the Earth is zero as calculated using current NASA software or other higher fidelity models.
9. Operation of the space stations will be compatible with existing operations in the authorized frequency bands. Operations will not materially constrain future space station entrants from using the authorized frequency bands.
10. The space stations can be commanded by command originating from the ground to immediately cease transmissions and the licensee will have the capability to eliminate harmful interference when required under the terms of the license or other applicable regulations.
11. Each space station is 10 cm or larger in its smallest dimension.

⁴ Although Section 25.122 requires only that proposed space stations be deployed at an orbital altitude of 600 km or below *or* be capable of making collision avoidance and deorbit maneuvers using propulsion to qualified for the requirements for streamlined processing under the Commission's small-satellite rules, Capella's satellites will satisfy both of these two alternative requirements.

12. Each space station will have a mass of 180 kg or less, including any propellant.
13. The probability that any individual space station will become a source of debris by collision with small debris or meteoroids that would cause loss of control and prevent disposal is 0.01 (1 in 100) or less.
14. Upon receipt of a space situational awareness conjunction warning, Capella will review and take all possible steps to assess the collision risk, and will mitigate the collision risk if necessary. As appropriate, steps to assess and mitigate the collision risk should include, but are not limited to: contacting the operator of any active spacecraft involved in such a warning; sharing ephemeris data and other appropriate operational information with any such operator; and modifying space station attitude and/or operations.

II. Spectrum use and sharing capabilities

Capella is committed to ensuring equitable sharing among all licensed co-frequency spectrum users. Capella satellites will operate in all frequency bands used in a manner that will avoid harmful interference. Capella has signed a coordination agreement with NASA, the U.S. Air Force and other federal agencies in order to assure that critical services are not impacted by the operation of the Capella system.

Because the modification requested herein would reduce the operational altitude of Capella-5, the power flux density (“PFD”) and certain non-interference showings for that satellite may differ marginally from those provided in Capella’s underlying application (i.e., the application pursuant to which Capella-5 and Capella-6 are currently authorized). However, Capella-5, operating under the modification requested herein, will share all pertinent orbital and radiofrequency characteristics with Capella-3. Therefore, Capella’s PFD and noninterference showings included in that application will apply equally to Capella-5. Accordingly, Capella incorporates by reference the PFD contours in section V of the technical attachment accompanying

that application⁵ as well as the demonstrations relating to PFD limits and other sharing criteria included in section VII of that document.

III. Orbital Debris Mitigation

The modest change in orbital parameters, with no alteration at all to the physical design of the spacecraft, does not materially alter the potential for Capella-5 to become a source of debris. Therefore, except as noted below, Capella incorporates by reference sections X and XI of the technical Attachment included with the underlying application for authority to launch and operate Capella-5 and -6.⁶

However, out of an abundance of caution, Capella has prepared an updated ODAR report for the modified Capella-5/6 system using NASA's Debris Assessment Software (DAS v.3.1). This updated analysis reflects the original orbital parameters for Capella-6 in combination with the changes requested herein for Capella-5. The updated probability of damage from a small object is 0.00029, easily below the compliance thresholds established by ODAR requirements. The probability of collision with a large object is 0.0001—again, compliant with NASA and Commission standards. The updated analysis indicates that both satellites will fully demise during uncontrolled re-entry with no material surviving to reach the Earth's surface. Accordingly, the risk of human casualty on the ground from Capella satellites re-entering the atmosphere remains 1:100000000.⁷

⁵ See Technical Attachment, SAT-LOA-20200914-00108 § 5.

⁶ See Technical Attachment, SAT-LOA-20210119-00012 § X, XI.

⁷ DAS is not capable of producing a value of exactly zero under any circumstances, with the minimum value of 1:100000000 serving as its functional equivalent.

IV. Other matters

A. Related FCC authorizations

Capella has been issued two space-station authorizations pursuant to the Commission's small-satellite rules under the call signs S3073 and S3080. This application seeks to modify the latter of these authorizations.

In addition, Capella has pending two applications for Special Temporary Authority to operate a ground-based calibration system for the Capella-5 and Capella-6 SAR antennas under the file numbers SES-STA-20210316-00513 and SAT-STA-20210401-00044. As discussed below, Capella requests equivalent authority to transmit calibration signals to Capella-5 as modified herein.

Capella was issued an experimental radio authorization under Call Sign WJ2XJE on August 31, 2018 (*see* OET ELS File No. 0066-EX-CN-2018). This license was used in the deployment and operation of Capella's first satellite, called "Denali," in 2018. Capella has since sought and obtained a modification of that license (*see* OET ELS File No. 0029-EX-CM-2020) to permit experimental operation of Capella-3 as well as an additional experimental authorization for Capella-2 under Call Sign WL2XAD, which was launched on August 30, 2020 (*see* OET ELS File No. 0228-EX-CN-2020). Finally, the Commission granted commercial authorization for the Capella-2, Capella-3 and Capella-4 satellites under Call Sign S3073 on December 17, 2020 (*see* IBFS File No. SAT-LOA-20200914-00108). Additionally, Capella has been engaged in a testing program of SAR technology using aircraft mounted sensors flying at altitudes of up to 10,000 feet at several locations in the United States (*see, e.g.*, OET ELS File Nos. 0903-EX-ST-2019 and 0203-EX-ST-2020).

B. NOAA authorization

Capella has been issued a license to operate a private remote sensing space system by NOAA's National Environmental Satellite, Data, and Information Service which authorized the remote sensing operations described in the underlying application. The modifications requested herein do not affect the applicability of that authorization to any Capella satellite.

C. Temporary authorization for ground-based calibration signal

Capella has requested special temporary authority to operate a ground-based system for calibrating Capella's synthetic aperture radar systems for a limited period following deployment of the radars in space.⁸ Because that STA will likely have expired before launch of Capella-5, Capella hereby requests authority to operate this system pursuant to the modified authorization for launch and operating authority requested herein for a period of 30 days after Capella-5 is deployed.

These operations will be limited to brief periods of transmission of a low power signal from the ground to the spacecraft. The ground-based system will transmit a calibrated CW tone in the direction of the spacecraft as it passes overhead. The tone will be tuned to the frequency of the Capella radar and the power level carefully controlled. The ground-station antenna will track the spacecraft using a commercial off-the-shelf computer-controlled telescope mount. The power received by the spacecraft radar receiver will be used to radiometrically calibrate radar measurements. The ground station will follow the spacecraft as the spacecraft traverses the sky but transmit only when the spacecraft is more than 10 degrees above the horizon. Orientation of the ground station antenna in the horizontal plane (degrees from true north) and orientation in the vertical plane (degrees from horizontal) will vary continuously as the ground station transmits.

⁸ *Application for Special Temporary Authority*, SES-STA-20210316-00513 (filed Mar. 16, 2021); *Application for Special Temporary Authority*, SAT-STA-20210401-00044 (filed Apr. 8, 2021).

The characteristics of these transmissions are specified below. (Because these transmissions will originate exclusively from the ground, they cannot be captured on the associated Schedule S.)

Transmitter Location:

San Francisco, CA

Within 50 miles of 37° 46' 26" N, 122° 25' 52" W

Height: < 6m

RF Characteristics:

Frequency: 9.4 – 9.9 GHz +/- 0.00025%

Output Power: 25W / 1412.5 W EIRP (Peak)

Beamwidth at the half-power point: 12°

Capella hereby requests a waiver of the Commission's Table of Allocations to permit these earth-to-space transmissions. Because these transmissions will be extremely brief, occur only over a limited time after deployment, and be directed towards the Capella satellite, they present little significant risk of harmful interference to other systems.

D. Waiver of Limitations in Schedule S and Section 25.114(c)

Capella has submitted with this application a completed Schedule S, which contains certain technical information in a prescribed form. Capella has found that it cannot accurately describe its system in certain respects due to limitations in Schedule S itself. Below we discuss several aspects of the system that fall into this category, as well as how Schedule S was completed in light of these limitations. To the extent necessary, Capella requests that the Commission waive these aspects of the requirement to complete Schedule S.⁹

⁹ Capella also requested certain other waivers in connection with its underlying application for launch and operating authority for Capella-5 and -6. To the extent necessary, Capella incorporates those waiver requests herein. *See* Waiver Requests, SAT-LOA-20210119-00012 § X, XI.

First, section 25.114(c)(4)(v) requires both the minimum and maximum saturation flux density (“SFD”) values for each space station receive antenna that is connected to transponders. The concept of SFD only applies to “bent pipe” satellite systems, and thus is not relevant to the Capella system. However, the Schedule S system does not allow an entry of “not applicable.” Instead, it requires a numerical entry for SFD, which must include different maximum and minimum values. In order to accommodate this requirement, Capella has entered values of “0” and “-0.1” in Schedule S with respect to these parameters.

Second, Schedule S requires completion of the field “Polarization Alignment Relative to the Equatorial Plane” for antennas with linear polarizations such as Capella’s SAR emitter. However, due to Capella’s orbital and operational characteristics — in particular, the fact that the Capella system is an NGSO, not a GSO system — Capella’s satellites will not operate with a consistent alignment relative to the equatorial plane. Thus, Capella has entered a value of 0 for this parameter.

Third, Capella’s payload downlink beam at 8043.75–8381.25 MHz has a switchable polarization between LHCP and RHCP. However, Schedule S does not permit this information to be correctly entered. Thus, Capella has completed that form to indicate only LHCP polarization.

Fourth, Schedule S requires submission of a channel plan for each transmit and receive beam. However, as explained in Capella’s Technical Attachment, Capella’s space-to-space links will operate on channels, and with bandwidths, specified by Inmarsat. Accordingly, it is not possible for Capella to provide a specific channel plan beyond the information provided in the Technical Attachment. Therefore, for each space-to-space beam, Capella has entered information for only a single channel on Schedule S, which will not be representative of Capella’s anticipated operations. Likewise, because PFD and EIRP density of Capella’s space-to-space transmissions

will vary depending on bandwidth, Capella has provided the worst-case EIRP density and PFD values on Schedule S.

Finally, Schedule S does not appear to permit a two-digit value for the field “Active Service Arc End Angle,” making it impossible to properly represent full-arc coverage (i.e. 0-360 degrees). Capella has entered 0 for both begin and end values in light of this limitation to reflect full-arc coverage.

E. ITU Filings

ITU notifications have already been submitted for the Capella-2, Capella-3, and Capella-4 satellites. No information has yet been submitted to the ITU for Capella-5 or Capella-6. Capella understands that additional ITU filings will be required and will unconditionally accept all consequent ITU cost recovery responsibilities.

Respectfully submitted,

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