March 29, 2021

VIA IBFS

Momentus Inc.
3050 Kenneth Street
Santa Clara, CA 95054

Karl A. Kensinger
Acting Chief, Satellite Division
International Bureau
Federal Communications Commission
45 L Street, NE
Washington, DC 20554

RE: Response to FCC Letter
IBFS File No.: SAT-STA-20210210-00020

Dear Karl:

Momentus Inc. ("Momentus") hereby responds to your letter dated March 24, 2021, requesting additional information and clarifications regarding the above-referenced application.[1] For your convenience, the questions (without footnotes) are reproduced below in italics.

1. The material submitted on February 10 appears to omit various clarifications and corrections provided in connection with an earlier application. To the extent that this application is intended to seek authorization for the same operations as those described in IBFS File No. SAT-STA-20200609-00068, including the various clarifying statements provided as part of that file, please provide the relevant clarifications and any additional information that was filed with the prior VR-1 application. This includes, but is not limited to, clarifying when the spacecraft will be deployed following orbital insertion.

Momentus confirms that the above-referenced application seeks authorization for the same operations as those described previously in IBFS File No. SAT-STA-20200609-00068, and that Momentus intended to include the various clarifying statements provided as part of that proceeding in the letter submitted in that earlier proceeding on August 14, 2020.[2] For the avoidance of doubt and at your request, Momentus hereby affirms and/or clarifies, as applicable,

[1] *See* Letter to Philip Hover-Smoot, Momentus Inc., from Karl A. Kensinger, FCC (March 24, 2021).
[2] *See* Letter to Jose P. Albuquerque, Chief, Satellite Division, International Bureau, FCC, from Philip Hover-Smoot, Chief Ethics & Compliance Officer, Momentus Inc., IBFS File No. SAT-SAT-20200609-00068 (August 14, 2020).

the following statements, which are consistent with the statements previously made on August 14, 2020 letter:[3]

- The ownership information and responses to questions 29-34 and 36-40 of the Form 312 are provided in Exhibit 2 of the above-referenced application and pages 15-16 of the application narrative ("Narrative").

- Customer payloads will be deployed at the insertion orbit following commissioning and preliminary testing and prior to any orbit-raising maneuvers. *See* Narrative at 3 and 5. Item 5 in the summary of the VR-1 concept of operations (Narrative at 8; ODAR at p. 5) incorrectly states that customer payloads will be deployed after orbit raising.

- The only ground stations to be used for the VR-1 mission are located at Vimercate, Italy and Cork, Ireland, which are identified in the application. *See, e.g.,* Narrative at 11-12.

- Momentus will be communicating on the requested frequency bands, as necessary, for the full 180 days. It is possible that some portion of the 180 days will include time when VR-1 has a perigee lower than 300 km. For clarity, spacecraft disposal - *i.e*., the period of time following the lowering of perigee to 300 km - is planned to begin prior to the 180-day mark. To the extent possible, Momentus will continue to conduct telemetry, tracking, and command communications during the period when the perigee of VR-1 is below 300 km. *See* Narrative at 2.

- The VR-1 will operate with an approximately 18% margin of propellant, in addition to the propellant necessary to achieve the operational concept (including lowering of perigee to 300 km at end of mission). Momentus contemplates that this reserve will serve as support for all contingencies during the VR-1 mission, including orbital debris avoidance maneuvers. To clarify, the VR-1's capacity for "real time collision avoidance and orbital maintenance maneuvers," is constrained by the availability of uplink and downlink opportunities and thus such maneuvers may not be available in real time during those parts of orbit that are outside of ground station range. The amount of reserve remaining following an orbital debris avoidance maneuver would depend on the nature and duration of the avoidance maneuver. Anecdotally, however, a single kilogram of propellant can power many kilometers of orbital adjustment. Additionally, there is historical evidence that collision avoidance maneuvers are rare, and conjunction avoidance is usually accomplished with orbital adjustments of less than 1 km. Accordingly, Momentus expects to have sufficient propellant reserves to conduct multiple contingency operations, including during spacecraft disposal. *See* Narrative at 5-6.

[3] Some of the statements made in the August 14, 2020, letter correct errors in the prior filing or pertain to facts that are no longer relevant (e.g., the total mass of the original VR-1 mission). Momentus has omitted repeating those statements or clarifications.

- Momentus has obtained a commercial remote sensing license from the National Oceanic and Atmospheric Administration. *See* Narrative at 9 n. 13. Momentus submitted a modification to that license, which was approved on March 24, 2021.

- The electromagnetic emissions of the VR-1 thruster would not exceed 15 uV/m at a distance of 300 meters. Our calculations indicate the thruster is expected to produce electromagnetic emissions at levels less than 10 uV/m at a distance of 300 meters. *See* Narrative at 12.

- The peak gain value for the transmit beam is 5.15 dB. The peak gain value for the receive beam is 6 dB. *See* Narrative at 11.

2. Please provide correct or provide further explanation concerning the provided antenna contours, as those filed with the application appear inconsistent with the other application information.

Momentus incorrectly submitted the antenna contours associated with the VR-2 mission as part of the VR-1 application. Attached as Exhibit 1 are the correct antenna contours. These contours are identical to the antenna gain contours (dated August 8, 2020), which were submitted on August 19, 2020 in the prior application proceeding, IBFS File No. SAT-STA-20200609-00068.

3. Please clarify which version of the NASA Debris Assessment Software (DAS) was used, and if any calculations are based on a past version of the DAS (other than 3.1.0), please provide updated calculations.

The ODAR analysis provided in this application was based on NASA DAS version 3.1.0. The information provided in response to question 4 *infra* is also based on NASA DAS version 3.1.0.

4. Please provide a worst-case calculation of large object collision risk for the VR-1 taking into account a scenario where the customer spacecraft remain onboard following orbit-raising.

Please see attached Exhibit 2. As demonstrated in the attached exhibit, VR-1 remains compliant with requirement 4.5-1, which requires that the probability of accidental collision with space objects larger than 10 cm in diameter be less than 0.001.

***

If you require any further information related to this application, please contact Philip Hover-Smoot at 415.254.1295 or via phhs@momentus.space.

Very Respectfully,

Philip Hover-Smoot
Deputy General Counsel
Chief Ethics & Compliance Officer
Momentus Inc.

Attachments: Exhibit 1 – Vigoride-1 NGSO Antenna Contour Gain Plots
Exhibit 2 – Vigoride-1 Worst Case Large Object Collision Risk

cc: Merissa Velez
Jay Whaley

Exhibit 1 – VR-1 NGSO Antenna Gain Plots

Vigoride-1 Spacecraft
NGSO Antenna Gain Plots

V3
03/24/2021

Momentus Inc.

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Revision History

1	Initial Release	All	Sam Avery	08/07/20
2	Updated contour labels	All	Sam Avery	08/08/20
3	Re-issued	All	Sam Avery	03/24/21

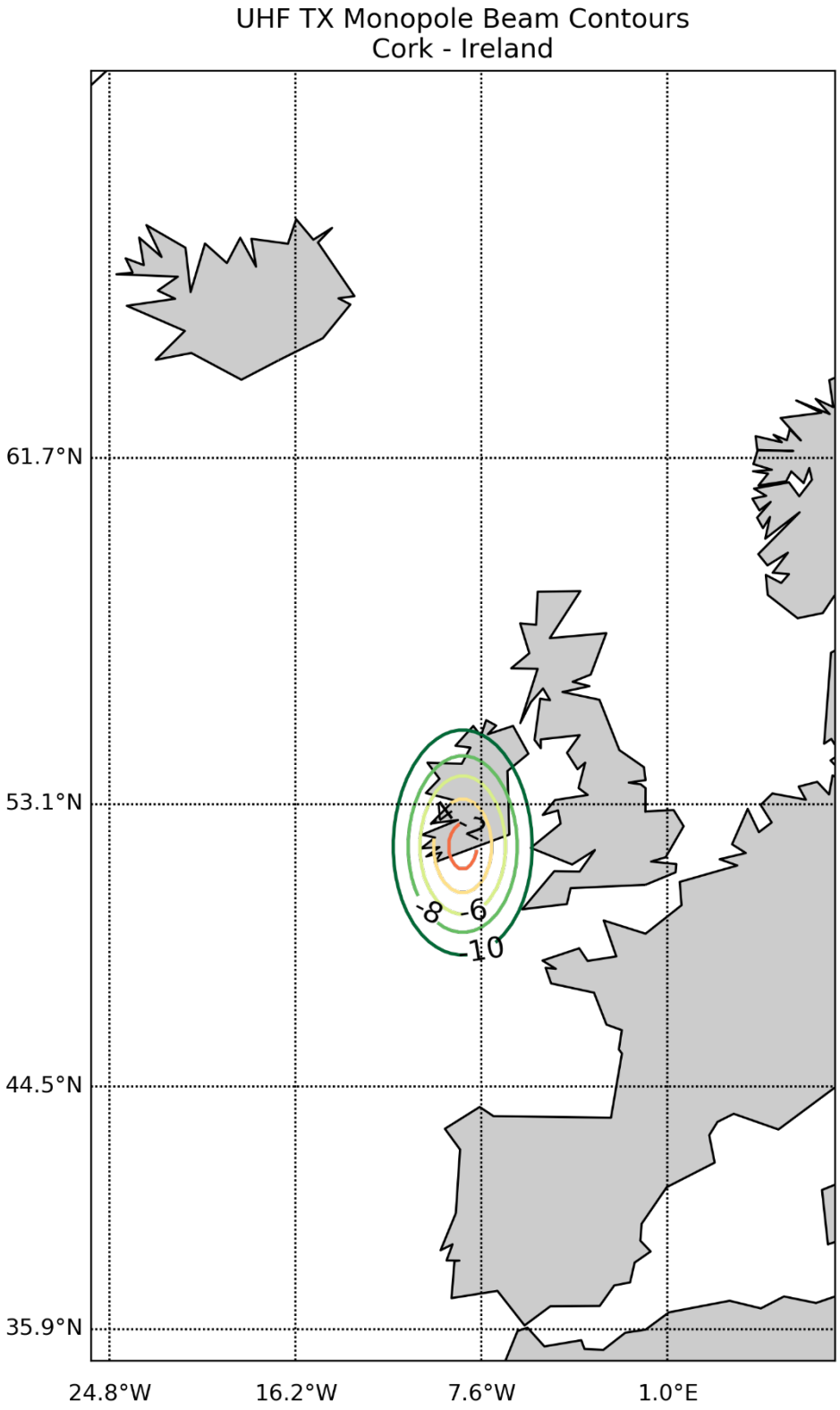
Table of Contents

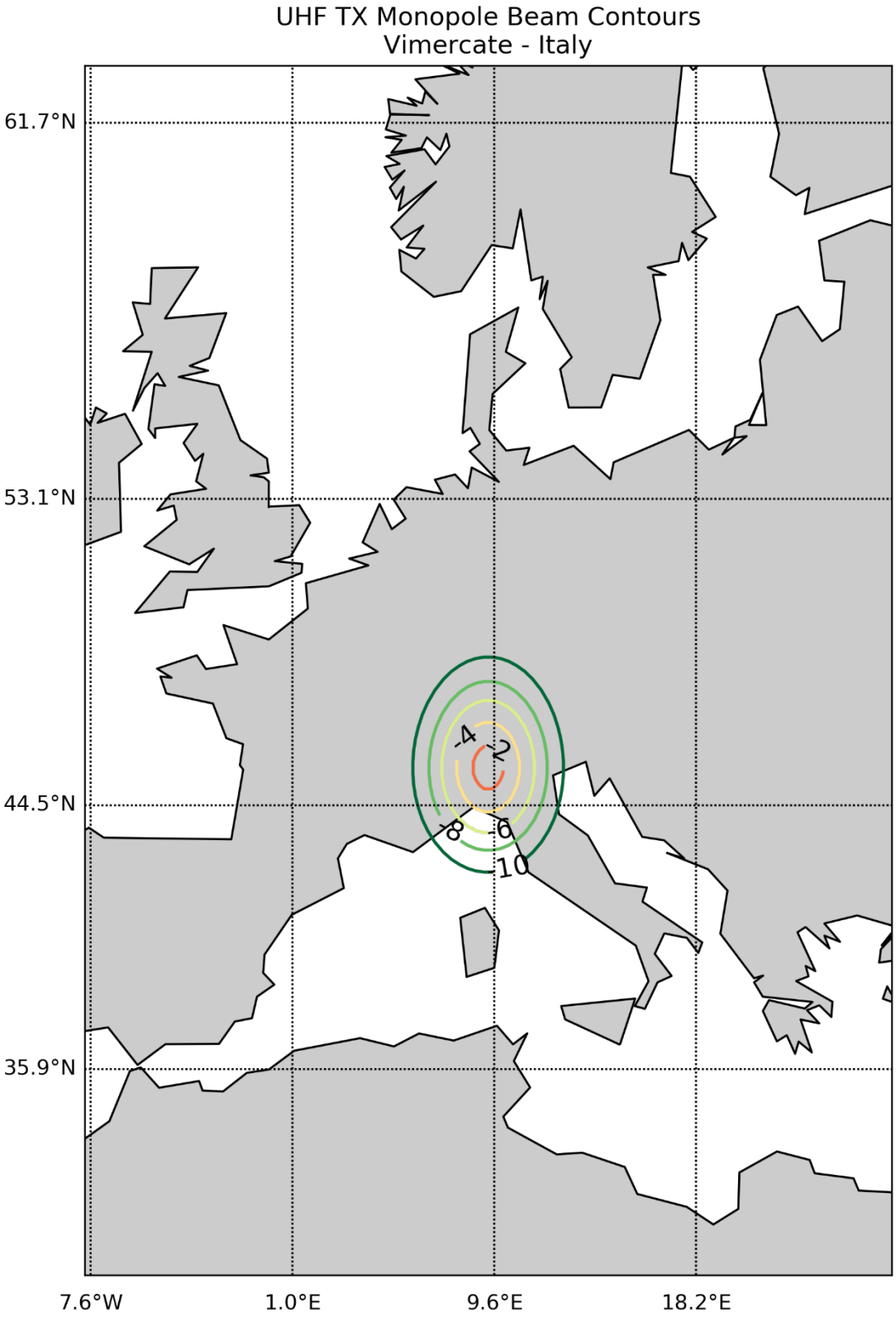
I. Introduction

All contour plots show a map of the Earth out to the horizon for each ground station and satellite antenna pair. The plot labels indicate antenna gain contours in 2 dB steps down to 10 dB below the peak gain. For instance, a contour label of "-2" indicates 2 dB below the maximum gain for that antenna.

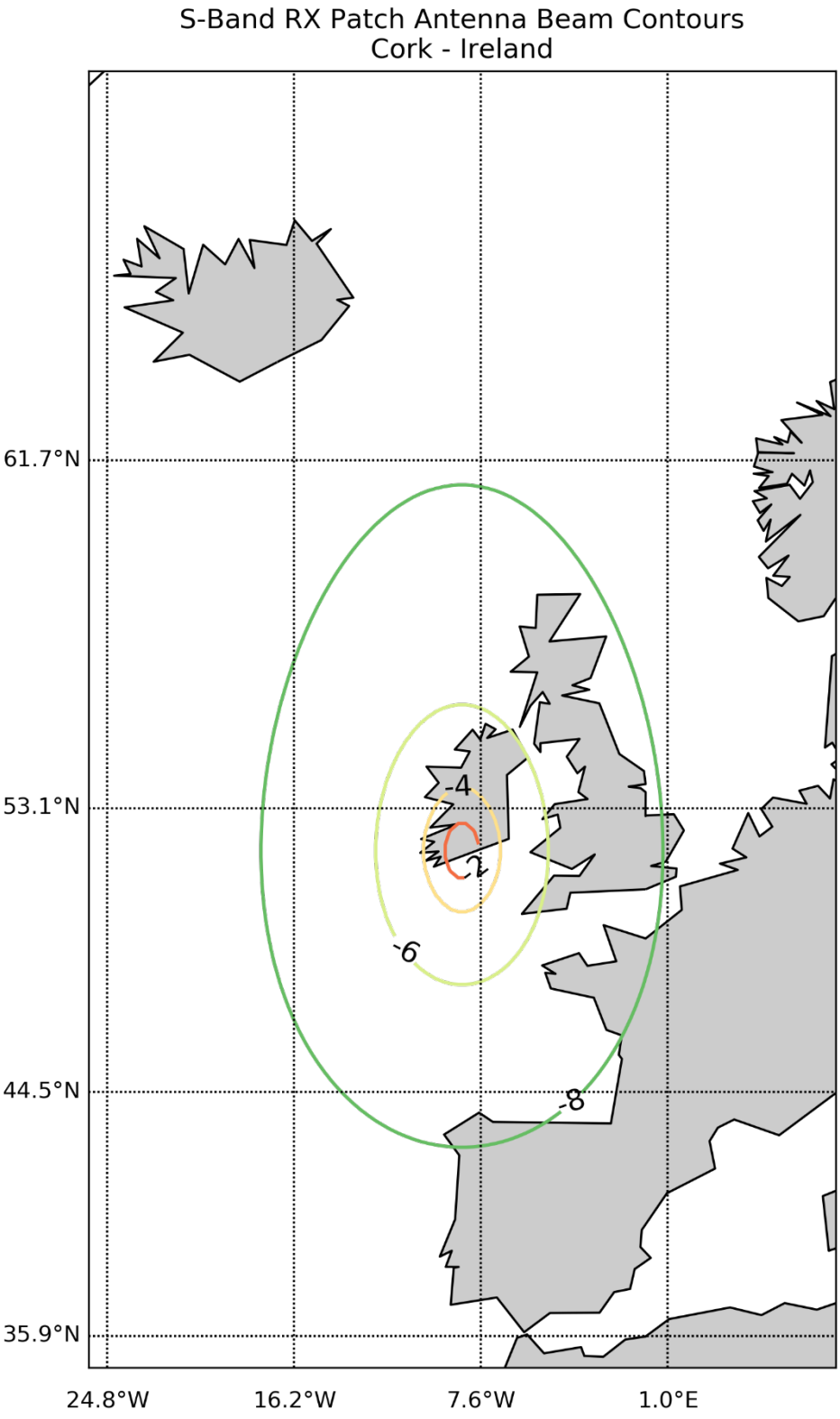
Note that for the Uplink (S-band receive) gain contour plots, the point of 10 dB below peak gain is beyond the horizon and is not shown in the plots.

II. Downlink Gain Contour Plots




UHF TX Monopole Beam Contours
Vimercate - Italy
61.7°N
53.1°N
44.5°N
35.9°N
7.6°W
1.0°E
9.6°E
18.2°E
-4
-2
-8
-6
-10

III. Uplink Gain Contour Plots



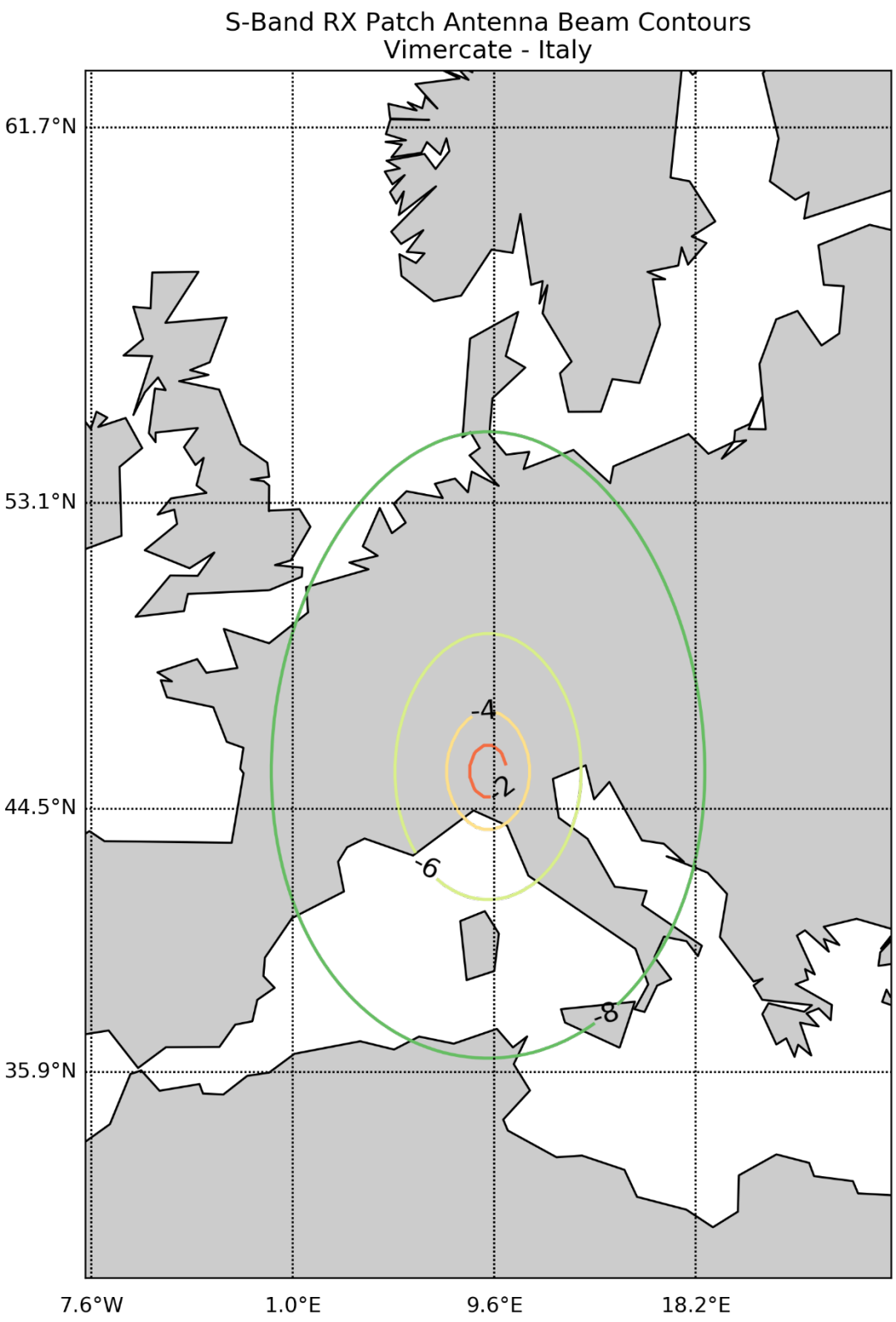

S-Band RX Patch Antenna Beam Contours
Vimercate - Italy
61.7°N
53.1°N
44.5°N
35.9°N
7.6°W
1.0°E
9.6°E
18.2°E
-4
-2
-6
-8

Exhibit 2 – VR-1 Worst-Case Large Object Collision Risk

03 24 2021; 16:37:45PM Opened Project C:\Users\sam.avery\Momentus\Engineering - Documents\Guilds\Systems Guild\Simulation and Analysis\Debris Assessment Software\NASA\DAS3.1.0\project - V1\
03 24 2021; 16:38:23PM Mission Editor Changes Applied
03 24 2021; 16:38:23PM Project Data Saved To File
03 24 2021; 16:38:40PM Processing Requirement 4.3-1: Return Status : Not Run
==========
No Project Data Available
==========
========== End of Requirement 4.3-1 ==========
03 24 2021; 16:38:43PM Processing Requirement 4.3-2: Return Status : Passed
==========
No Project Data Available
==========
========== End of Requirement 4.3-2 ==========
03 24 2021; 17:58:32PM Processing Requirement 4.5-1: Return Status : Passed
==========
Run Data
==========
INPUT
Space Structure Name = Vigoride-1
Space Structure Type = Payload
Perigee Altitude = 570.000 (km)
Apogee Altitude = 570.000 (km)
Inclination = 98.000 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass Ratio = 0.0040 (m^2/kg)
Start Year = 2021.600 (yr)
Initial Mass = 161.000 (kg)
Final Mass = 161.000 (kg)
Duration = 1.000 (yr)
Station-Kept = False
Abandoned = True
OUTPUT
Collision Probability = 4.8995E-05
Returned Message: Normal Processing
Date Range Message: Normal Date Range
Status = Pass
==========
========== End of Requirement 4.5-1 ==========
03 24 2021; 17:58:36PM Project Data Saved To File
03 24 2021; 18:06:14PM Requirement 4.5-2: Compliant
==========
Spacecraft = Vigoride-1
Critical Surface = Avionics
==========
INPUT

Apogee Altitude = 570.000 (km)
Perigee Altitude = 570.000 (km)
Orbital Inclination = 98.000 (deg)
RAAN = 0.000 (deg)
Argument of Perigee = 0.000 (deg)
Mean Anomaly = 0.000 (deg)
Final Area-To-Mass = 0.0040 (m^2/kg)
Initial Mass = 161.000 (kg)
Final Mass = 161.000 (kg)
Station Kept = No
Start Year = 2021.600 (yr)
Duration = 1.000 (yr)
Orientation = Random Tumbling
CS Areal Density = 5.000 (g/cm^2)
CS Surface Area = 0.5000 (m^2)
Vector = (0.000000 (u), 0.000000 (v), 0.000000 (w))
CS Pressurized = No
Outer Wall 1 Density: 10.000 (g/cm^2) Separation: 30.000 (cm)
OUTPUT
Probability of Penetration = 7.3801E-06 (7.3801E-06)
Returned Error Message: Normal Processing
Date Range Error Message: Normal Date Range
========== End of Requirement 4.5-2 ==========