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Appendix A

RESPONSE TO QUESTION 7 OF FCC FORM 442 (PURPOSE OF EXPERIMENT)

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DISTRIBUTION STATEMENTS:
Unrestricted

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Unrestricted

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Configuration Control

Checker	**Sign to Release**
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Checker	Name: David Langan

Revisions

Revision	**Date**	**Changes**
01	TBD	Initial Revision

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1.0 Narrative Summary

Umbra Lab Inc. ("Umbra Lab") is a satellite imaging company, headquartered in Santa Barbara, California. This space-based radar imaging data will be made available commercially for defense, intelligence and analytics solutions. Umbra Lab's synthetic aperture radar (SAR) microsatellites can deliver sub-meter imagery as a service. Our space-based radar can capture images day and night regardless of weather conditions, for delivery via an integrated web platform.

To collect our radar imagery Umbra Lab has developed a proprietary antenna design allowing for relatively low power operation to achieve high quality SAR images. Umbra Lab's SAR satellites will transmit a Linear Frequency Modulated Up-Chirp or Down-Chirp X-band imaging radar pulse and can transmit from 9.2 – 10.4 GHz. The radar has a modulated signal Bandwidth of 1,200 MHz, a PRF of 2-8 kHz, and a Duty Cycle of <20%. The Satellite also utilizes radio communication for command and control and downlinking of stored radar imagery data to ground stations as specified in section 2.0 below. For low bandwidth communications the Satellites will utilize its Innoflight S-Band radio to transmit and receive data at 2250-MHz once a communications link is closed as scheduling allows with any of the below mentioned ground stations. The downlinking of mission data is handled by higher bandwidth X-Band communication utilizing KSAT's capability at 8050-MHz.

For the above Umbra Labs seeks the use of the following frequency bands:

1. 2025-2110 MHz for uplinking command and control data. (US347)
2. 8025-8400 MHz for downlinking mission data. (US258)
3. 9300-10000 MHz for SAR imaging. (allocated on a secondary basis for non-Federal EESS)

Umbra Lab plans a constellation of SAR satellites and is initially seeking approval from the FCC for an experimental license for operation of the first two spacecraft to be launched in 2020. We plan to submit for approval for the full constellation

once the design is validated through the emerging Small Satellite Licensing Procedures announced in FCC-18-44.

The purpose of the first two satellites launched in 2020 will be to test our technologies and designs, validate our performance, and progress into our fully operational architecture. Technology developments being tested include but are not limited to our high resolution and low power SAR payload, power systems, thermal systems, resilient RF electronics, mission operations architecture, mission Con-Ops, data and telemetry downlink systems, and ground systems architecture.

Umbra SAR utilizes commercially available spacecraft components where practical to do so. Our propulsion system is water based easing manufacturing processes and providing a proven means of maintaining our orbit and assuring safety of flight over the proposed lifetime for each satellite of five years. Our guidance and navigation systems are also derived from flight proven designs assuring highly accurate pointing to within 0.5-arcseconds of intended collection or ground communication targets.

Mission control of UmbraSAR satellites will be located at Umbra Lab's headquarters located in Santa Barbara, CA with a mobile back-up. Tasking will be generated, encrypted and passed through "bent-pipe" to the satellites utilizing the KSAT ground stations indicated below. Mission Data and Telemetry will be packetized and encrypted onboard and sent to ground through the same ground terminals during a communication windows. Amazon Web Services (AWS) is utilized for storage and distribution of data through Umbra's web portal following raw data processing.

All of the aspects of the Umbra SAR system described above will provide high quality and high reliability SAR imagery to our customers for the life of the planned missions.

2.0 Ground Station Information

Ground Station services for uplink and downlink will be provided by Kongsberg Satellite Services (KSAT) at the following ground sites:

Table 1: Ground Station 1

Location	Svalbard
Geographic Location	78°13'47.18"N, 15°24'28.03"E
Diameter (m)	3,7m
Half-power beamwidth S-Band	2.55° @2250MHz
Half-power beamwidth X-Band	0.8° @8050MHz
Maximum Output Power S-band (W)	25.1
Minimum Output Power S-band (W)	0
EIRP (dBW)	44.8
Receiving system noise temperature S-band (K)	235
Receiving system noise temperature X-band (K)	95
Maximum isotropic Gain gain S-band (dBi)	35.4
Main Beam Antenna gain X-band (dBi)	47
Beamwidth (degrees)	1.3
Minimum supported elevation range	5
Azimuthal range (degrees)	360
Polarization	LHCP or RHCP

Table 2: Ground Station 2

Location	Troll
Geographic Location	72°01'00"S, 2°32'00"E
Diameter (m)	3,7m
Half-power beamwidth S-Band	2.55° @2250MHz
Half-power beamwidth X-Band	0.8° @8050MHz
Maximum Output Power S-band (W)	25.1
Minimum Output Power S-band (W)	0
EIRP (dBW)	44.8
Receiving system noise temperature S-band (K)	235
Receiving system noise temperature X-band (K)	95
Maximum isotropic Gain gain S-band (dBi)	35.4

Main Beam Antenna gain X-band (dBi)	47
Beamwidth (degrees)	1.3
Minimum supported elevation range	5
Azimuthal range (degrees)	360
Polarization	LHCP or RHCP

Table 3: Ground Station 3

Location	Hartebeesthoek
Geographic Location	25°53'25"S, 27°41'08"E
Diameter (m)	3,7m
Half-power beamwidth S-Band	2.55° @2250MHz
Half-power beamwidth X-Band	0.8° @8050MHz
Maximum Output Power S-band (W)	25.1
Minimum Output Power S-band (W)	0
EIRP (dBW)	44.8
Receiving system noise temperature S-band (K)	235
Receiving system noise temperature X-band (K)	95
Maximum isotropic Gain gain S-band (dBi)	35.4
Main Beam Antenna gain X-band (dBi)	47
Beamwidth (degrees)	1.3
Minimum supported elevation range	5
Azimuthal range (degrees)	360
Polarization	LHCP or RHCP

Table 4: Ground Station 4

Location	Punta Arenas
Geographic Location	53°9’00"S, 70°55’12’’W
Diameter (m)	3,7m
Half-power beamwidth S-Band	2.55° @2250MHz
Half-power beamwidth X-Band	0.8° @8050MHz
Maximum Output Power S-band (W)	25.1
Minimum Output Power S-band (W)	0
EIRP (dBW)	44.8
Receiving system noise temperature S-band (K)	235
Receiving system noise temperature X-band (K)	95
Maximum isotropic Gain gain S-band (dBi)	35.4

Main Beam Antenna gain X-band (dBi)	47
Beamwidth (degrees)	1.3
Minimum supported elevation range	5
Azimuthal range (degrees)	360
Polarization	LHCP or RHCP

Table 5: Ground Station 5

Location	Awarua
Geographic Location	46°30’47”S, 168°22’33”E
Diameter (m)	3,7m
Half-power beamwidth S-Band	2.55° @2250MHz
Half-power beamwidth X-Band	0.8° @8050MHz
Maximum Output Power S-band (W)	25.1
Minimum Output Power S-band (W)	0
EIRP (dBW)	44.8
Receiving system noise temperature S-band (K)	235
Receiving system noise temperature X-band (K)	95
Maximum isotropic Gain gain S-band (dBi)	35.4
Main Beam Antenna gain X-band (dBi)	47
Beamwidth (degrees)	1.3
Minimum supported elevation range	5
Azimuthal range (degrees)	360
Polarization	LHCP or RHCP

Appendix A

Acronyms and Abbreviations

A.1 Acronyms

TBD	To Be Determined
TBR	To Be Revised

A.2 Abbreviations

m^2	Square Meters