ASTRA RROCI Satellite
FCC Experimental License Application File No.: 0867-EX-CN-2021

Supplemental Exhibit – Responses to FCC Questions dated December 13, 2021

Please address the following questions and concerns from IB:

(Responses are in blue following each question)

1) Please remove the sections from the NTIA Space Record Data Form that concern Globalstar and resubmit.

   Completed December 13, 2021

2) Please provide the Globalstar companion filing reference number.

   Globalstar will not be filing a companion application, because the link to the Globalstar satellite is transmit-only from RROCI.

3) Please uncheck the 4.4 designation for the X-Band downlink.

   See updated SpaceCap file submitted to ELS.

4) Please confirm the minimum power density for the X-Band downlink in the spacecap. A quick check indicates the value would be around -75, not -210.

   See updated SpaceCap file submitted to ELS with corrected information.

5) Please confirm the minimum power density for the S-Band downlink in the spacecap. A quick check indicates the value would be around -63, not -220.

   See updated SpaceCap file submitted to ELS with corrected information.

6) Please confirm the minimum power density for the S-Band uplink in the spacecap. A quick check indicates the value would be around -47, not -180.

   See updated SpaceCap file submitted to ELS with corrected information.

7) What is the metal be using as propellant?

   a. Primarily Molybdenum (99.9% pure).

8) Please confirm if propulsion will be used for collision avoidance maneuvers (with other space craft and debris).

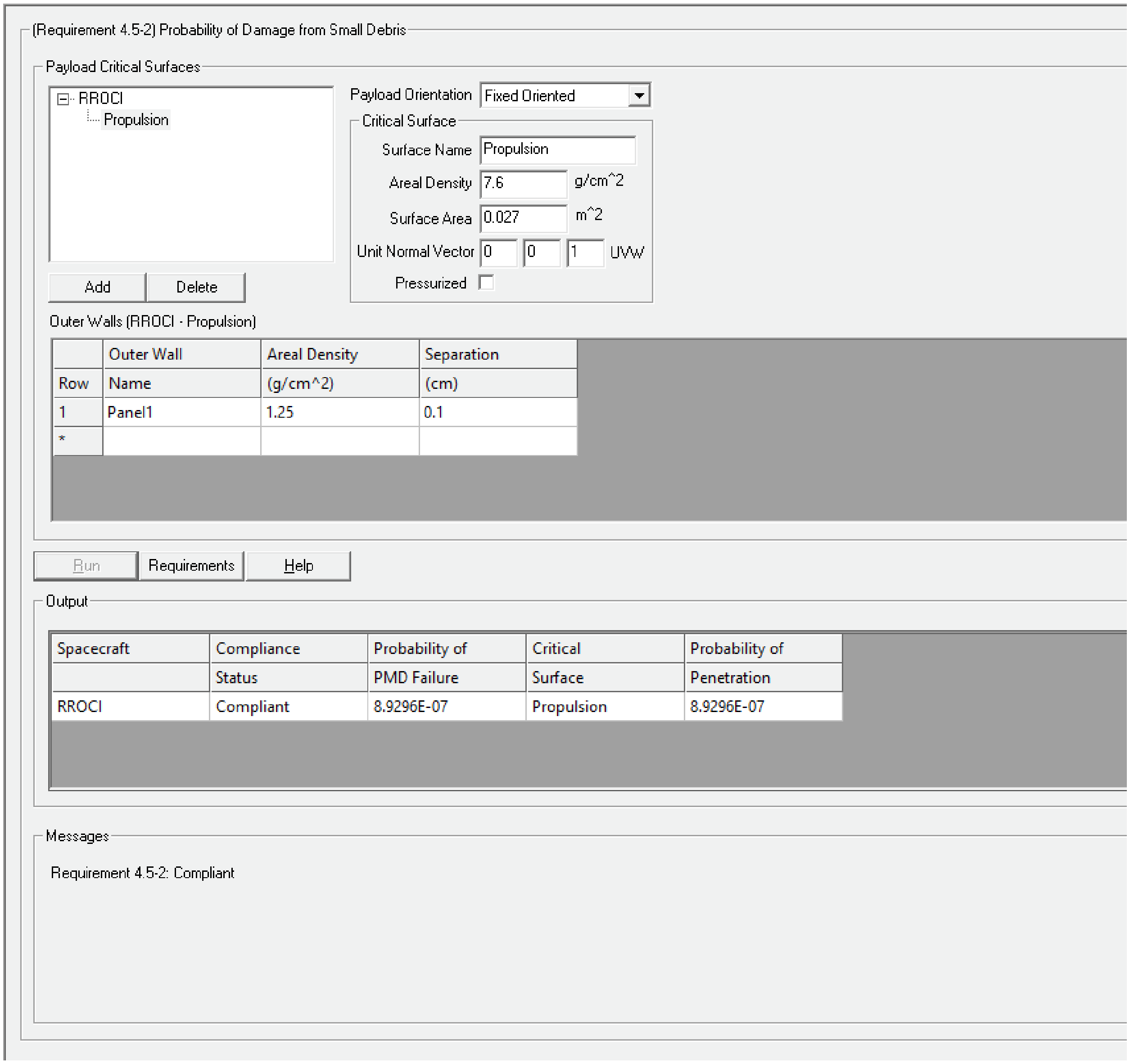
a. The propulsion is not currently planned for use for collision avoidance maneuvers. The response time for action is too short to be successfully used in this manner.

9) Please confirm if propulsion will be used for stationkeeping, and if so, to what tolerances (+/- altitude, inclination, etc.)

a. Yes, the propulsion system will be used for station keeping throughout the year long mission. The MPT thruster is pulsed and offers fine control of impulse bits: as small as 0.1mill-Newton-seconds per pulse. This single pulse corresponds to a Delta-V of 5 micrometer/second [5E-6 m/s] for a 20kg CubeSat. By simple switch control, the impulse may be made even smaller if desired. No other propulsion is capable of such fine control. On the other hand, use of multiple pulses allows higher Delta-V changes. For example, a burst of 1000 pulses (takes 16 minutes at 1Hz firing rate), along with the nominal 0.2mNs impulse bit would impart a Delta-V of 1cm/s to a 20kg CubeSat.

10) Please provide the small object collision risk value as required for spacecraft that will be performing post mission disposal efforts.

a. The screenshot below provides the proper risk value.


(Requirement 4.5-2) Probability of Damage from Small Debris

Payload Critical Surfaces

RROCI
Propulsion

Add | Delete

Payload Orientation: Fixed Oriented

Critical Surface
Surface Name: Propulsion
Areal Density: 7.6 g/cm^2
Surface Area: 0.027 m^2
Unit Normal Vector: 0 0 1 UVW
Pressurized

Outer Walls (RROCI - Propulsion)

Row	Outer Wall Name	Areal Density (g/cm^2)	Separation (cm)
1	Panel1	1.25	0.1
*			

Run | Requirements | Help

Output

Spacecraft	Compliance Status	Probability of PMD Failure	Critical Surface	Probability of Penetration
RROCI	Compliant	8.9296E-07	Propulsion	8.9296E-07

Messages

Requirement 4.5-2: Compliant

11) Please provide additional detail regarding the system mass budget table on page 5. Please provide the full names of every title and item in the table.

CBE: Current Best Estimate
TRL: Technology Readiness Level
MEV: Maximum Expected Value
MPE: Maximum Parameter Envelope
MVE: *Typo, should read MEV
MRG: Margin

ADCS: Attitude Determination and Control System
SADA: Solar Array Drive Actuators

WFDL: WarFighter DownLink
OM: Optics Module
LWIR: Long Wave IR
MWIR: Mid Wave IR
SWIR: Short Wave IR
VIS: Visible

12) In the event of a propulsion system failure, please provide the orbital lifetime of the spacecraft for both the deployed and stowed configurations at the initial altitude of 642 km.

See Attachment A.

13) What is the area-to-mass value of the spacecraft in both the stowed and deployed configurations?

	Description	Stowed	Deployed	Deployed @ 90°
	Solar Arrays	7.27	7.55	683.13
	12U Body	119.89	119.89	119.89
	Solar Array Bumpers	0.25	0.25	
	Panel Hinge Mechanism (Exposed)		0.04	
			0.20	
			0.67	
Total (in^2)		127.41	127.69	803.02

14) Please provide the preliminary plans for controlled reentry of the spacecraft as required by NASA STD 8719.14b.

a. The onboard propulsion system will be fired in the anti-velocity vector at each orbit apogee, thereby slowing down the spacecraft and reducing the perigee of the orbit every orbit. The perigee will be lowered to create a highly elliptical orbit of 280x642km. Any remaining fuel will be used burning at perigee in the anti-velocity vector of every orbit to drop the apogee and re-enter the spacecraft. This is expected to happen at mission launch + 12 months currently. The re-entry time period is expected to take no longer than 90 days.

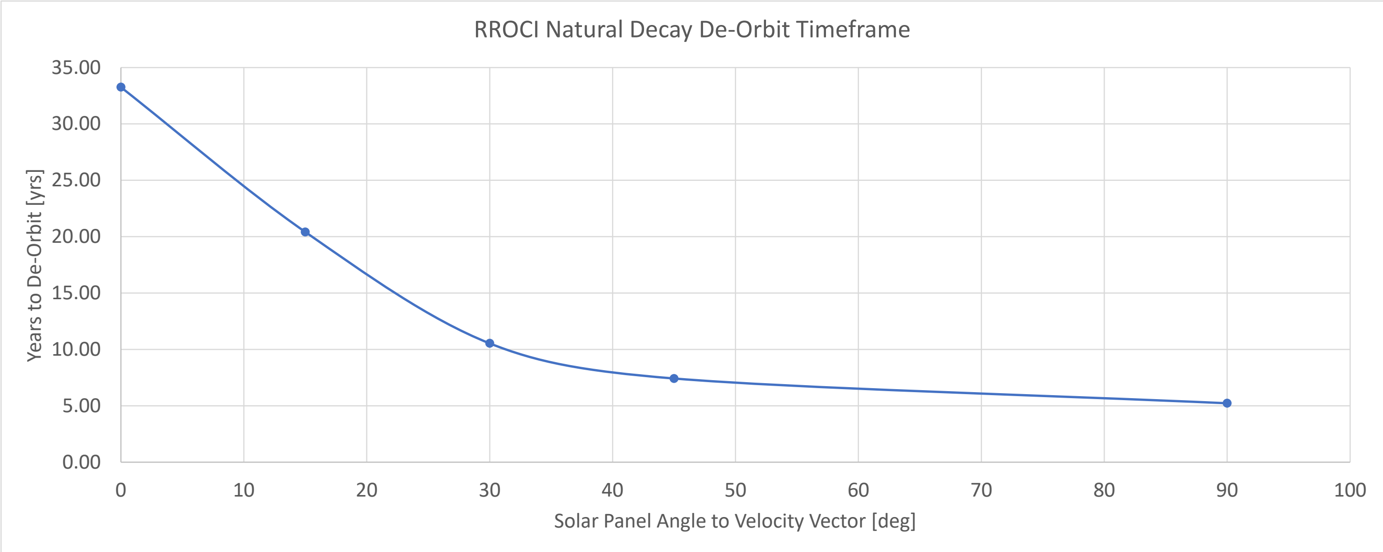
Attachment A

Start Date:	4/1/2023
Start Time:	0:00:00

De-orbit defined as satellite at 150 km altitude; Satellite: 18.4839 kg; 642 km altitude; 98.5 deg incl
Calculated using JGM2 Gravity Field, MSISE90 Atmosphere Model, Spherical Drag Model
Calculated using NASA General Mission Analysis Tool (GMAT) R2020a

Engineer:	Erik Stromberg
Company:	ASTRA, LLC
Date:	12/21/2021

Panel Angle to Velocity Vector	S/C Cross Sectional Area	De-Orbit Date	De-Orbit Time	Fraction of Day	Days to De-Orbit	Years to De-Orbit
[deg]	[in^2]	MM/DD/YY	H:MM:SS			
0	127.7	6/25/2056	1:34:19	0.07	12139.07	33.26
15	207.8	8/26/2043	19:37:32	0.82	7452.82	20.42
30	401.5	10/11/2033	4:03:24	0.17	3846.17	10.54
45	567.8	8/31/2030	4:25:10	0.18	2709.18	7.42
90	803.0	6/20/2028	5:57:34	0.25	1907.25	5.23



At end of mission life, if we orient our solar panels to at least 15 degrees in the velocity vector and lock them in place, the satellite will meet the orbital lifetime requirements if the propulsion system fails.