February 10, 2021

VIA IBFS

Marlene H. Dortch
Secretary
Federal Communications Commission
45 L Street, NE
Washington, DC 20554

Re: Submission of Updated Orbital Debris Assessment Report and Ownership Information for VR-2
IBFS File No. SAT-STA-20200831-00102

Dear Ms. Dortch:

Momentus Inc. ("Momentus") submits an updated orbital debris assessment report ("ODAR") and ownership exhibit. In relevant part, the ODAR reflects changes in:

- VR-2's scheduled launch date from February 2021 to June 2021;
- the insertion orbit from 464 km (~97.4 deg.) to 550 km (~98 deg.); and
- the concept of operations to include post-deployment phasing of customer spacecraft.[1]

The revised ODAR confirms VR-2 would be expected to de-orbit in less than 25 years after the mission lifetime and the risk of casualty meets the FCC's requirements. Except as stated specifically in this letter, Momentus certifies that VR-2's proposed operations are otherwise materially the same.

If you require further information regarding this update, please contact Philip Hover-Smoot at +1 415-254-1295 or phhs@momentus.space.

Respectfully submitted,

/s/ Philip Hover-Smoot

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

Enclosure

[1] *See* Exhibit 2, ODAR at n.4.

EXHIBIT 1

Updated Ownership Information

Momentus Inc. ("Momentus") is a privately held corporation.

Listed below are the entities that currently have a 10% or greater equity and/or voting interest in Momentus: [1]

1. **Mikhail Kokorich directly and/or indirectly**
   c/o Momentus Inc.

   3050 Kenneth Street

   Santa Clara, CA 95054

   Ownership Interest: approximately 19% (see discussion below)

   Voting Interest: approximately 47% (see discussion below)

   Nationality: Russia

2. **Olga Khasis directly and/or indirectly[2]**
   16047 Collins Avenue, Unit 1603

   Sunny Isles Beach, Florida 33160

   Ownership Interest: approximately 17% (see discussion below)

   Voting Interest: approximately 36% (see discussion below)

   Nationality: U.S.

3. **Dakin Sloss**
   General Partner, Prime Movers Lab ("PML")

   PO Box 12829

   Jackson, WY 83002

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[1] The ownership percentages listed in this application are fully diluted percentages. All voting interests listed in this application are based on outstanding stock, taking into account that certain classes of stock are "high vote" stock with 10 votes per share.

[2] Ms. Khasis is the wife of Momentus' co-founder Lev Khasis, who is a Russian citizen and a U.S. permanent resident.

PML Ownership Interest: approximately 29%

PML Voting Interest: approximately 10%

OFFICERS, DIRECTORS, AND SENIOR LEADERS

All of the directors, officers, and senior leaders of Momentus may be reached at the following address:
c/o Momentus Inc.
3050 Kenneth Street
Santa Clara, CA 95054

CEO, Director	*Dawn Harms*[3]
President	*Dr. Fred Kennedy*
Director, Chairman	*Dakin Sloss*
Director	*Vince Deno*
General Counsel	*Alexander Fishkin*
Assoc. General Counsel	*Philip Hover-Smoot*
CFO	*Jikun Kim*
CTO	*Rob Schwarz*
Controller	*Temitope Oduozor*

Further Discussion

Momentus recently underwent a significant change in our senior leadership. Effective January 23, 2021, Mr. Kokorich, one of the co-founders of Momentus, resigned as CEO and as a member of Momentus's Board of Directors. Dawn Harms, who was previously the company's Chief Revenue Officer, has been appointed as interim CEO and has been elected as a member of the Board of Directors.

In parallel with Mr. Kokorich's resignation, and with the express goal of fully addressing the U.S. government's national security concerns, Mr. Kokorich and Ms. Khasis and their related entities are committing to divest all shares they hold in Momentus directly or indirectly. Mr. Kokorich and entities related to him plan to give up their voting rights in Momentus by placing all Momentus shares

[3] Each senior leader or director listed is a U.S. citizen. Additionally, the following leaders hold current or unassigned but activatable Personal Security Clearances: Dawn Harms (TS/SCI), Fred Kennedy (TS/SCI), Philip Hover-Smoot (S), and Rob Schwarz (S).

they own into trusts whereby a proxyholder designated by Momentus will vote such shares and these shareholders will cooperate with Momentus by agreeing to the divestiture of their shares by the trusts. The proxyholder will vote all of Mr. Kokorich's shares in his or her sole discretion. The voting interest held by Mr. Kokorich (directly and indirectly) is planned to be assigned to the interim CEO of the Company, Dawn Harms. After his and his related entities' shares are moved into trusts, Mr. Kokorich will not be able to exert any control with respect to Momentus. Prior to the placement of the shares in trust, Mr. Kokorich and his related entities are committing to refrain from voting their shares or taking any action to influence Momentus. The Momentus shares owned by Ms. Khasis also will be moved to a trust to be divested and the voting of such shares will be controlled by a designated proxyholder who is a U.S. citizen.

Momentus plans to merge with Stable Road Acquisition Corp. (Nasdaq ticker symbol: SRAC) ("SRAC"), which is a publicly traded special purpose acquisition company and will be listed as a publicly traded company (the "SPAC Transaction"). After the closing, no persons will have any board appointment or nomination rights. Momentus and SRAC have agreed that the six-member board will consist of (1) the interim CEO of Momentus, Dawn Harms (who is a U.S. citizen), (2) Brian Kabot, the Chairman and Chief Executive Officer of SRAC (who is a U.S. citizen), (3) three independent directors, Vince Deno, David Siminoff, and Chris Hadfield (Mr. Deno and Mr. Siminoff are U.S. citizens and Mr. Hadfield is a Canadian citizen); and (4) a sixth independent director who has not yet been identified, which were jointly agreed between Momentus and SRAC, subject to approval by a majority vote of SRAC's shareholders.

Momentus will update the Commission of changes.

Exhibit 2

Vigoride-2 Spacecraft

Orbital Debris Assessment Report (ODAR)

Rev2

02/09/2021

Momentus Inc.

3050 Kenneth Street

Santa Clara, CA 95054

+1 (650) 564-7820

Document contains no ITAR or otherwise restricted data.

DAS Software Version used in Analysis: v3.1.0

Revision History

Revision Number	Updates	Page #	Author	Date
1	Initial Release	All	Sam Avery	08/30/20
2	Minor updates based on launch date shift	All	Sam Avery	02/09/21

Table of Contents

Sam Avery

Sam Avery
Regulatory Technical Lead, Vigoride-2
Momentus

Orbital Debris Self-Assessment Evaluation

Reqm't #	Launch Vehicle: Compliant	N/A	Not Compliant	Std. Non-Compliant	Incomplete	Spacecraft: Compliant	N/A	Not Compliant	Incomplete	Comments *For all incompletes, include risk assessment (low, medium, or high risk) of non-compliance & Project Risk Tracking #*
4.3-1.a *25 year limit*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1. No debris released.
4.3-1.b *<100 object x year limit*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1. No debris released.
4.3-2 *GEO +/- 200km*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1. No debris released.
4.4-1 *<0.001 Explosion Risk*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1.
4.4-2 *Passivate Energy Sources*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1.
4.4-3 *Limit BU Long term Risk*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1. No intentional breakups.
4.4-4 *Limit BU Short term Risk*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1. No intentional breakups.
4.5-1 *<.001 10cm Impact Risk*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1.
4.5-2 *Postmission Disposal Risk*	☐	☐	☐	☐	☐	☒	☐	☐	☐	
4.6-1a-c *Disposal Method*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1.
4.6-2 *GEO Disposal*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1.
4.6-3 *MEO Disposal*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1.
4.6-4 *Disposal Reliability*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1.
4.7-1 *Ground Population Risk*	☐	☒	☐	☐	☐	☒	☐	☐	☐	See comment 1.
4.8-1 *Tether Risk*	☐	☐	☐	☐	☐	☒	☐	☐	☐	No tethers used.

Comment 1. This ODAR analyzes only VR-2 and provides representative information regarding the customer payloads. The launch vehicle and other launch vehicle payloads are not considered in this ODAR.

Assessment Report Format

ODAR Technical Sections Format Requirements: This ODAR follows the format recommended in NASA-STD-8719.14, Appendix A.1 and includes the content indicated at a minimum in sections 2 through 8 for the Vigoride-2 ("VR-2") satellite. Sections 9 through 14 of the NASA standard apply to the launch vehicle ODAR and are not covered here.

I. Program Management and Mission Overview

Project Manager:

- Sam Avery

Foreign Government or space agency participation:

- None

Schedule of Upcoming Mission Milestones:

- Launch - June 2021

Mission Overview:

Momentus is a private U.S. company headquartered in Santa Clara, California. Momentus is engaged in the design, construction, and operation of in-space transportation spacecraft. Since its founding in 2017, Momentus has brought together a team of aerospace professionals, drawn from throughout the industry, united with the singular goal of changing how the world thinks about space transportation infrastructure. Through its revolutionary Vigoride spacecraft, each capable of transporting and delivering small satellites to tailored orbital locations, Momentus will provide efficient and inexpensive "connecting flights" in space. The ability to customize orbits using Vigoride spacecraft empowers small satellite operators by enabling greater and lower-collision risk use of all orbits, including high-density orbits. Additionally, introducing the orbit flexibility of the Vigoride spacecraft into the existing commercial rideshare launch market can accelerate commercial space station deployments by expanding the orbital reach of existing launches, thereby increasing total ridership and contributing to lower launch prices. Cheaper, faster and smarter commercial space transportation has the capability to fundamentally change how space operators interact with on-orbit infrastructure.

This ODAR evaluates the Momentus demonstration mission, Vigoride-2 ("VR-2"), which is planned to launch on a SpaceX Falcon-9 rocket in June 2021. For the demonstration mission, VR-2 will exhibit the capacity to transport and deploy multiple payloads. Each customer satellite payload is a commercial smallsat individually licensed and authorized to operate by each respective national jurisdiction.[1] The necessary de-orbit and debris analysis for customer satellite payloads will be addressed through the licensing process for the relevant payload.[2]

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[1] General information regarding the customer satellites is provided in Table 1 in the application narrative.
[2] In the event the customers are unable to secure the requisite licensing for their respective payloads, Momentus will launch VR-2 with a representative mass, and such mass shall not be deployed.

Launch Vehicle:

- Falcon-9

Expected Launch Site:

- Cape Canaveral Space Launch Complex (SLC-40 or SLCE-4E)

Operational Mission Duration:

- Planned for 180 days.

The VR-2 concept of operations is as follows:

1. Launch vehicle arrives at initial orbit: maximum 550 km circular sun-synchronous orbit with approximately a ~98 degree inclination[3]
2. VR-2 separates from launch vehicle
3. VR-2 undergoes commissioning and preliminary testing
4. VR-2 deploys payloads[4]
5. VR-2 conducts orbit raising maneuvers to 550 km circular second primary orbit[5]
6. VR-2 performs detailed system functional testing
7. VR-2 conducts inclination change maneuvers to lower inclination by 0.3 degrees.
8. VR-2 conducts apogee change maneuvers to raise apogee to 580 km
9. VR-2 conducts perigee change maneuvers to raise perigee to 580 km circular third primary orbit
10. VR-2 conducts maneuvers to reduce RAAN by -1 degrees
11. VR-2 conducts maneuvers to return VR-2 to 550 km SSO second primary orbit
12. VR-2 conducts perigee change maneuvers to lower perigee to 250 km
13. VR-2 conducts apogee change maneuvers to raise apogee to 1,000 km fourth primary orbit
14. VR-2 conducts de-orbit maneuvers (targeting 150 km perigee)

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[3] SpaceX reports a planned injection orbit of 525 km (± 25 km).

[4] All VR-2 payload deployments will be performed in a cadence designed to limit potential immediate collision or subsequent re-conjunction during initial orbits. Deployments of LabSat, Stork 1, Stork 2, Stork 3, and SteamSat are expected to include an even spacing in true anomaly. Further, Kepler-16 and Kepler-17 are also expected to include an even spacing in true anomaly.

[5] The second primary orbit is indicated as a maximum 550 km circular sun-synchronous orbit, based on a planned 25 km raise from a notional minimum 500-525 km insertion orbit.

Table 1: Orbital Parameters

	VR-2 Insertion Orbit[6]	Second Primary Orbit	Third Primary VR-2 Orbit	Fourth Primary VR-2 Orbit	VR-2 End-of-Life Orbit
Apogee Altitude	550 km (max)	550 km (max)	580 km (max)	1,000 km (max)	1,000 km (max)
Perigee Altitude	550 km (max)	550 km (max)	580 km (max)	250 km	150 km[7]
Inclination	~98° (Sun-Synchronous)	~98° (Sun-Synchronous)	~98° (Sun-Synchronous)	~98° (Elliptical)	~98° (Elliptical)
Period	96 mins	96 mins	96 mins	105 mins	105 mins
Argument of Perigee	N/A	N/A	N/A	N/A	N/A
Local Time of the Ascending Node (LTAN)	~01:30	~01:30	~01:30	~01:30	~01:30
Maximum De-Orbit Life	VR-2[8] ~21 years	VR-2[9] ~15 years	VR-2[10] ~22 years	VR-2 ~2 years	VR-2 ~2 months

[6] As discussed above, the VR-2 insertion orbit is also the insertion orbit of all customer payloads.
[7] The target perigee as a result of de-orbit maneuvers is expected to be 150 km.
[8] This is the de-orbit duration if VR-2 has a propulsion system *and* a solar array deployment failure after deployment from the launch vehicle.
[9] This is the de-orbit duration if VR-2 has a propulsion system failure after raising the orbit to 550 km altitude.
[10] This is the de-orbit duration if VR-2 has a propulsion system failure after raising the orbit to 580 km altitude.

II. Spacecraft Description

Physical Description:

VR-2 has the following subsystems: Propulsion System, Structures, Mechanisms, Electric Power System, and Avionics.

VR-2 includes a primary and a secondary structural assembly with: Propellant Tanks, MET, Reaction Control System thrusters, Solar Array Assemblies, a launch vehicle separation ring, two ISIS 12U cubesat deployers, three 12U cubesat deployer mass dummies, one 3U cubesat deployer, and two PocketPod deployers.

VR-2 includes two 5-panel 600W deployable solar arrays which are deployed using a frangibolt Hold Down and Release Mechanism (HDRM). The solar array deployment is controlled by a software timer via the flight computer.

The Payloads are fully stowed in their deployers and their power is inhibited prior to on-orbit deployment. The Payloads will follow the form and mass characteristics of a standard cubesat of the relative U-size of the payload. The VR-2 spacecraft platform components all have their power inhibited until launch vehicle separation occurs.

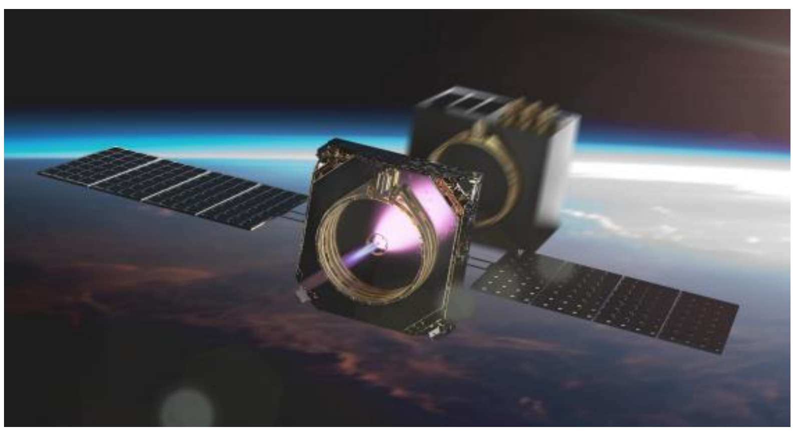


Figure 1. Artist rendering of Vigoride deploying a customer spacecraft.

Table 2. General Spacecraft Description

Criteria	Description	Notes
Spacecraft Total Launch Mass	469 kg	Includes 120 kg of propellant.
Spacecraft Launch Dry Mass	349 kg	
Propulsion System	Redundant MET and reaction control thrusters. See *Propulsion System Description*.	Propulsion system operates using non-toxic and low-pressure liquid water propellant.
Body Dimensions	1.2x1.2x1.1 m^3	
Deployed Solar Array Dimensions	1.07x2.76x0.03 m^3	Dimensions per solar array wing.
Identification of all Fluids	• Liquid/vapor water mixture (propellant) • Nitrogen (tank pressurant) • Helium (tank pressurant) • Dynalene HC-50 (Potassium Formate/H2O Solution – for cooling) See *Fluids Description*.	
Fluids in Pressurized Batteries	None. VR-2 uses unpressurized lithium ion cells.	
Attitude Determination and Control	Attitude Determination • Star Trackers • Sun Sensors • Gyroscopes Attitude Control • Reaction Control Thrusters See *Attitude Determination and Control System Description*.	

Range Safety or Pyrotechnic Devices	None	
Electrical Generation and Storage System	Two 600W solar array wings for power generation. Two 960 Wh batteries are included and charged prior to launch vehicle integration.	
Other Stored Energy	• Solar array spring energy stored in hinges. • Clampband separation system spring energy. • Payload deployer hinged door spring energy.	
Radioactive Materials	Not applicable.	

Propulsion System Description

The Vigoride-2 fully redundant propulsion system energizes distilled water into plasma using RF microwave energy. The plasma is expelled out of the thruster using a nozzle to produce thrust at a specific impulse (Isp) exceeding traditional chemical propulsion systems. The expected thrust and Isp will vary with input power levels but will not exceed 150 mN per thruster. The VR-2 mission will nominally include 120 kg of liquid water propellant at launch. The 120 kg of water is split into equal parts in the four on-board propellant tanks. The maximum expected total impulse is approximately 400 kNs.

In addition, there are eight reaction control thrusters each with estimated maximum thrust of 30 mN and specific impulse of 120 seconds. These reaction control thrusters are also redundant and use the same stored liquid water as a propellant.

Fluids Description

The propulsion system includes four monocoque tanks with liquid water propellant pressurized using inert gaseous Helium. Each diaphragm tank is expected to include 30 kg of propellant. At spacecraft integration the propellant tanks are pressurized to 18 psig. The tanks are expected to remain within 20% of this pressure during transportation to the launch site, during launch, and post launch until thruster operations.

Attitude Determination and Control System Description

The VR-2 spacecraft includes 3-axis control with reaction control thrusters. For attitude determination, the spacecraft includes redundant star trackers, sun sensors, and gyroscopes, providing nominally >1° pointing knowledge.

- A sun tracking mode that is optimized for solar power generation from the satellite. The spacecraft's body will be oriented in two axes, and on-board Solar Array Drive Assemblies (SADAs) will rotate the panels along the third axis.
- A targeted tracking mode will allow the thrust axis to be pointed in any direction in inertial space.

III. Spacecraft Debris Released during Normal Operations

Payload Re-Contact Mitigation

Momentus will plan to support at least three re-contact mitigation strategies, for deployments from VR-2:

1. Payload deployments will be spaced apart by at least 90 minutes, or 1 full orbit.
2. Payload deployments will alternate between along-track deployment with the velocity vector and with the anti-velocity vector.
3. On-board propulsion may also be used for maneuvers to minimize the risk of re-contact.

Persistent Liquids and Propellant-Related Debris

During primary mission operations, any water released into space through the MET or the reaction control thrusters will be vaporized at sufficiently high temperature (>500K) to prevent the formation of debris. In the off-nominal case of a leak or flow of liquid water, there is potential for the creation of small water ice crystals. Any generated water ice crystals are expected to sublimate within minutes of exposure to sunlight.

Assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2 (per DAS v3.1.0)

- **4.3-1, Mission Related Debris Passing Through LEO:** COMPLIANT
- **4.3-2, Mission Related Debris Passing Near GEO:** COMPLIANT

IV. Intentional Breakups and Potential for Explosions

Potential causes of spacecraft breakup during deployment and mission operations:

There are two potential scenarios that could potentially lead to a breakup of the satellite:

1) Rupture of the propellant tank or pressurant tank (H_20, He)
2) Lithium-ion battery cell failure

Summary of failure modes and effects analyses of all credible failure modes which may lead to an accidental explosion:

- In-mission failure of a battery cell protection circuit could lead to a short circuit resulting in overheating and a very remote possibility of battery cell explosion. The battery safety systems discussed in the failure modes and effects analysis ("FMEA") (see requirement 4.4-1 below) describe the combined faults that must occur for any of seven (7) independent, mutually exclusive failure modes to lead to an explosion.

Detailed plan for any designed spacecraft breakup, including explosions and intentional collisions:

- There are no planned breakups.

List of components which shall be passivated at End of Mission including method of passivation and amount which cannot be passivated:

- 192 Lithium-ion battery cells. At the End of Mission, the battery cell maximum charge voltage may be reduced.

Rationale for all items which are required to be passivated, but cannot be due to their design:

- None.

Assessment of spacecraft compliance with Requirements 4.4-1 through 4.4-4:

Requirement 4.4-1: Limiting the risk to other space systems from accidental explosions during deployment and mission operations while in orbit about Earth or the Moon:

For each spacecraft and launch vehicle orbital stage employed for a mission, the program or project shall demonstrate, via failure mode and effects analyses or equivalent analyses, that the integrated probability of explosion for all credible failure modes of each spacecraft and launch vehicle is less than 0.001 (excluding small particle impacts) (Requirement 56449).

Supporting Rationale and FMEA details:

- **Pressure Tank Explosion:**
    - **Effect:** A rupture of one propellant or pressurant tank would release water and helium. Due to the low pressure of the propellant (18 psi), the penetrating energy of any debris would be relatively low. In addition, a helium pressurant tank (250 psi) rupture would be insufficient to penetrate the surrounding solid aluminum structural walls of the spacecraft. These aluminum walls would contain any released debris within the body of the spacecraft.
    - **Probability:** Very low. A structural failure of the tank would need to occur, and the mechanisms by which these failures occur are very well understood. The factor of safety for the propellant tanks is at least 2, for the pressurant tanks is 40, and for the surrounding structure is greater than 2.
- **Battery explosion:**
    - **Effect:** All failure modes below might result in battery explosion with the possibility of orbital debris generation. However, in the unlikely event that a battery cell does explosively rupture, although the spacecraft could be expected to vent gases, most debris from the battery rupture should be contained within the vessel due to the lack of penetration energy and multiple enclosures surrounding the batteries.
    - **Probability:** Extremely Low. Estimated to be less than 0.01% given that multiple independent (not common mode) faults must occur for each failure mode to cause the ultimate effect (explosion).
    - **Failure Mode 1:** Internal short circuit.
        - *Mitigation 1:* All of the following testing has or will be performed prior to flight: qualification level sine burst, sine, and random vibration testing in all three axes, thermal vacuum cycling and extensive functional testing, system rate-limited charge and discharge cycles, and subsystem and component level functional testing. The testing helps prove that no internal short circuit sensitivity exists.
        - *Combined Faults Required for Realized Failure:* Environmental testing AND functional charge / discharge tests must both be ineffective in discovery of the failure mode.
    - **Failure Mode 2:** Internal thermal rise due to high load discharge rate.
        - *Mitigation 2:* Battery cells were tested in lab for high load discharge rates in a variety of flight-like configurations to determine the feasibility of an out-of-control thermal rise in the cell. Cells are also tested in a hot, thermal vacuum environment to test the upper limit of the cells' capability. No failures were observed or identified via satellite telemetry or via external monitoring circuitry.

        - *Combined Faults Required for Realized Failure:* Spacecraft thermal design must be incorrect AND external over-current detection and disconnect function must fail to enable this failure mode.
    - **Failure Mode 3:** Excessive discharge rate or short-circuit due to external devices failure of terminal contact with conductors not at battery voltage levels (due to abrasion or inadequate proximity separation).
        - *Mitigation 3:* Qualification testing of short circuit protection on each external circuit, design of battery packs and insulators such that no contact with nearby board traces is possible without being caused by some other mechanical failure, and observation of such other mechanical failures by protoflight level environmental tests (sine burst, random vibration, thermal cycling, and thermal-vacuum tests).
        - *Combined Faults Required for Realized Failure:* An external load must fail/short-circuit AND external over-current detection and disconnect function must all occur to enable this failure mode.
    - **Failure Mode 4:** Inoperable vents.
        - *Mitigation 4:* Battery venting is not inhibited by the battery holder design or the spacecraft design. The battery can vent gases to the external environment.
        - *Combined Faults Required for Realized Failure:* The cell manufacturer OR the satellite integrator fails to install proper venting.
    - **Failure Mode 5:** Crushing.
        - *Mitigation 5:* This mode is negated by spacecraft design with no moving parts in the proximity of the batteries.
        - *Combined Faults Required for Realized Failure:* A catastrophic failure must occur in an external system AND the failure must cause a collision sufficient to crush the batteries leading to an internal short circuit AND the satellite must be in a naturally sustained orbit at the time the crushing occurs.
    - **Failure Mode 6:** Low level current leakage or short-circuit through battery or short-circuit through battery pack case or due to moisture-based degradation of insulators.
        - *Mitigation 6:* The battery interface includes a printed circuit board and standoffs from any conductive materials, and operation in vacuum ensures that no moisture can affect insulators.
        - *Combined Faults Required for Realized Failure:* Abrasion or piercing failure of circuit board coating or wire insulators AND dislocation of battery packs AND failure of battery terminal insulators AND failure to

detect such failures in environmental tests must occur to result in this failure mode.

- **Failure Mode 7:** Excess temperatures due to orbital environment and high discharge combined.
    - *Mitigation 7:* The spacecraft thermal design will negate this possibility. Thermal rise has been analyzed in combination with space environment temperatures showing that the batteries do not exceed normal allowable operating temperatures under a variety of modeled cases, including worst case orbital scenarios. Analysis shows these temperatures to be well below temperatures of concern for explosions.
    - *Combined Faults Required for Realized Failure:* Thermal analysis AND thermal design AND mission simulations in thermal-vacuum chamber testing AND over-current monitoring and control must all fail for this failure mode to occur.

Requirement 4.4-2: Design for passivation after completion of mission operations while in orbit about Earth or the Moon:

Design of all spacecraft and launch vehicle orbital stages shall include the ability to deplete all onboard sources of stored energy and disconnect all energy generation sources when they are no longer required for mission operations or postmission disposal or control to a level which cannot cause an explosion or deflagration large enough to release orbital debris or break up the spacecraft (Requirement 56450).

- Compliance statement:
    - At End-of-Life, VR-2 can reduce stored energy in the battery and limit power generation capability of the solar arrays. In case of a battery failure, the cells are, at a minimum, doubly contained within aluminum structural walls to prevent debris generation.
    - All liquid water propellant has low stored energy (at 18 psi) and is chemically stable. The helium pressurant tanks, which have a maximum pressure of 250 psi and a factor of safety of 40, do not contain enough stored energy to penetrate or break apart the spacecraft structure.

Requirement 4.4-3: Limiting the long-term risk to other space systems from planned breakups:

- Compliance statement:
    - Not applicable. There are no planned breakups.

Requirement 4.4-4: Limiting the short-term risk to other space systems from planned breakups:

- Compliance statement:
    - Not applicable. There are no planned breakups.

V. Spacecraft Potential for On-Orbit Collisions

While the calculated risk of on-orbit collision with large debris or other operational space stations is low, Momentus shall monitor the VR-2 throughout the operational life of the spacecraft to ensure near real-time collision avoidance, as ground station available allows, and orbital maintenance maneuvers are executed as needed.[11] Additionally, this monitoring shall assess, on an ongoing basis, the accuracy with which the targeted orbital parameters are to be maintained.[12] Furthermore, the proposed operation of the VR-2 does not rely on or otherwise necessitate coordination with any other operational space stations and no assessment of successful coordination with such an operator has been performed to date.

Requirement 4.5-1. Limiting debris generated by collisions with large objects when operating in Earth orbit:

- For each spacecraft and launch vehicle orbital stage in or passing through LEO, the program or project shall demonstrate that, during the orbital lifetime of each spacecraft and orbital stage, the probability of accidental collision with space objects larger than 10 cm in diameter is less than 0.001 (Requirement 56506).
- **Large Object Impact and Debris Generation Probability:**
    - 8.7272E-5; COMPLIANT.

Requirement 4.5-2. Limiting debris generated by collisions with small objects when operating in Earth or lunar orbit:

- For each spacecraft, the program or project shall demonstrate that, during the mission of the spacecraft, the probability of accidental collision with orbital debris and meteoroids sufficient to prevent compliance with the applicable postmission disposal requirements is less than 0.01 (Requirement 56507).
- **Small Object Impact and Debris Generation Probability:**
    - 6.6820E-06; COMPLIANT

[11] VR-2 is capable of adjusting orbits at speeds that support dynamic collision avoidance. This near real-time orbital adjustment is feasible only when VR-2 is capable of communicating with the MOC, which is in turn dependent upon ground station availability. The VR-2 mission will launch a substantial propellant reserve which is intended to provide sufficient propellant to perform contingency operations (e.g., as needed collision avoidance maneuvers) during the mission while also retaining ample propellant to execute de-orbit maneuvers necessary to achieve end-of-mission timeline targets.

[12] The Momentus assessment of the VR-2's accuracy for orbital parameter maintenance indicates performance will be within the following ranges: Apogee, ±1km; Perigee, ±200m; Inclination, <1%: and the Right Ascension of the Ascending Node(s), <1%.

Identification of all systems or components required to accomplish any postmission disposal operation, including passivation and maneuvering:

- None are specifically required, but the propulsion system is expected to be used for a postmission de-orbit maneuver to decrease the time until atmospheric re-entry to less than 1 year. The flight computer, radio hardware, battery system, and control boards will be used to reduce stored energy.

VI. Spacecraft Postmission Disposal Plans and Procedures

Description of spacecraft disposal option selected:

- VR-2 will de-orbit naturally by atmospheric re-entry without any intervention. However, VR-2 will attempt a de-orbit maneuver to reduce the time to atmospheric re-entry to less than one year.

Plan for any spacecraft maneuvers required to accomplish postmission disposal:

- No maneuvers are required for postmission disposal. However, VR-2 will attempt de-orbit maneuvers as a proof of concept for future missions, as explained in the concept of operations (p. 6). Note that there is no planned controlled re-entry.

Calculation of area-to-mass ratio after postmission disposal, if the controlled reentry option is not selected:

- Spacecraft Final Mass: 469 kg
- Cross-sectional Area: 1.8 m^2 (estimated average area in tumbling without deployed solar arrays)
- Area to mass ratio: 0.004 m^2/kg

Requirement 4.6-1. Disposal for space structures passing through LEO:

A spacecraft or orbital stage with a perigee altitude below 2000 km shall be disposed of by one of three methods: (Requirement 56557)

1. Atmospheric reentry option:
    a. Leave the space structure in an orbit in which natural forces will lead to atmospheric reentry within 25 years after the completion of mission but no more than 30 years after launch; or
    b. Maneuver the space structure into a controlled de-orbit trajectory as soon as practical after completion of mission.
2. Storage orbit option: Maneuver the space structure into an orbit with perigee altitude greater than 2000 km and apogee less than GEO - 500 km.
3. Direct retrieval: Retrieve the space structure and remove it from orbit within 10 years after completion of mission.

Analysis:

VR-2 will follow a concept of operations to ensure a safe disposal within 25 years of the end of the mission.[13] Following mission completion, the thruster will be used to lower the perigee and reduce orbit lifetime to approximately 2 months. In the event of both a propulsion system failure *and* solar array deployment failure on launch, VR-2 is expected to undergo atmospheric re-entry within 21 years. *See* The VR-2 concept of operations is as follows:

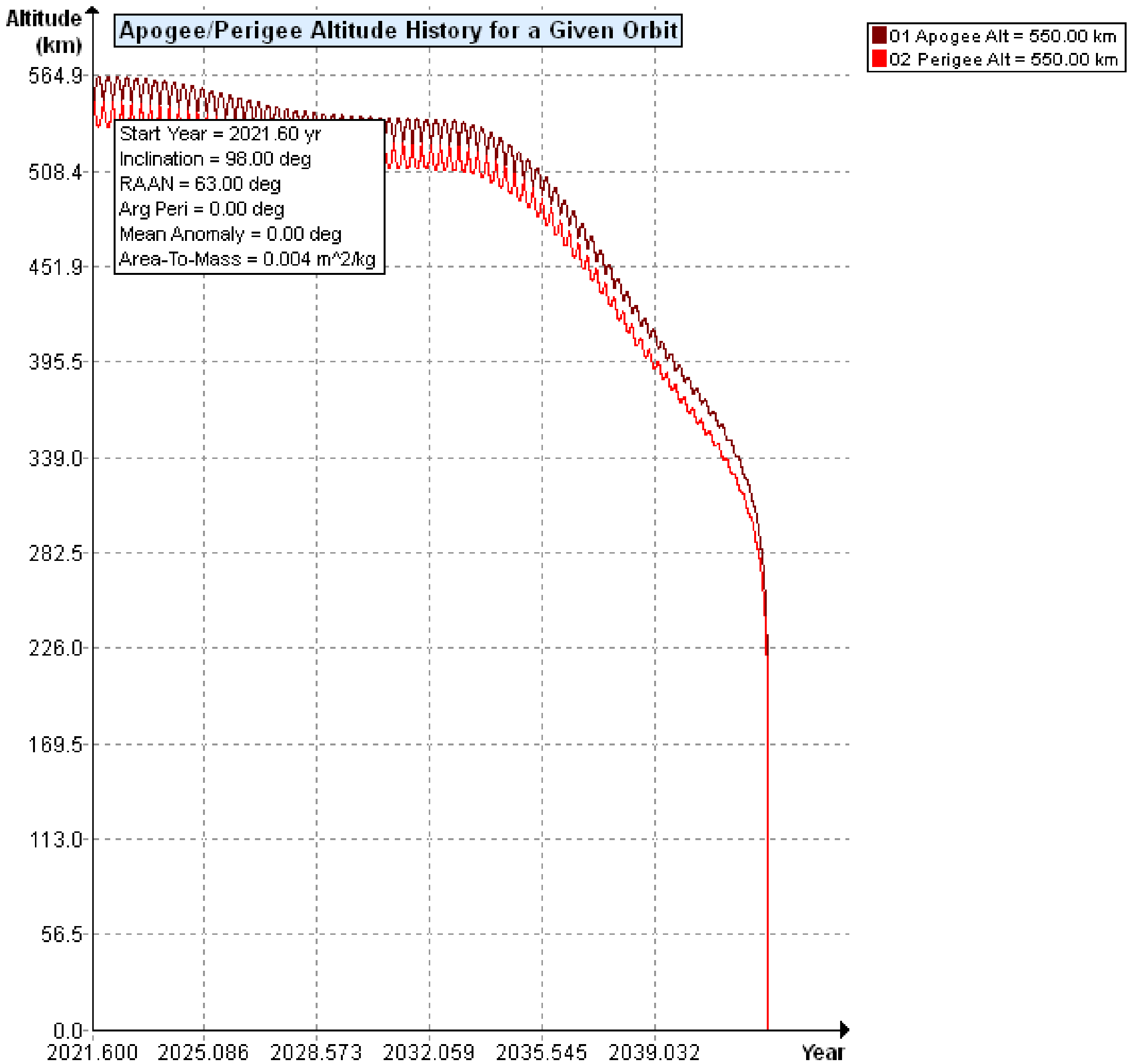
15. Launch vehicle arrives at initial orbit: maximum 550 km circular sun-synchronous orbit with approximately a ~98 degree inclination
16. VR-2 separates from launch vehicle
17. VR-2 undergoes commissioning and preliminary testing
18. VR-2 deploys payloads
19. VR-2 conducts orbit raising maneuvers to 550 km circular second primary orbit
20. VR-2 performs detailed system functional testing
21. VR-2 conducts inclination change maneuvers to lower inclination by 0.3 degrees.
22. VR-2 conducts apogee change maneuvers to raise apogee to 580 km
23. VR-2 conducts perigee change maneuvers to raise perigee to 580 km circular third primary orbit
24. VR-2 conducts maneuvers to reduce RAAN by -1 degrees
25. VR-2 conducts maneuvers to return VR-2 to 550 km SSO second primary orbit
26. VR-2 conducts perigee change maneuvers to lower perigee to 250 km
27. VR-2 conducts apogee change maneuvers to raise apogee to 1,000 km fourth primary orbit
28. VR-2 conducts de-orbit maneuvers (targeting 150 km perigee)

Table 1 *supra*.

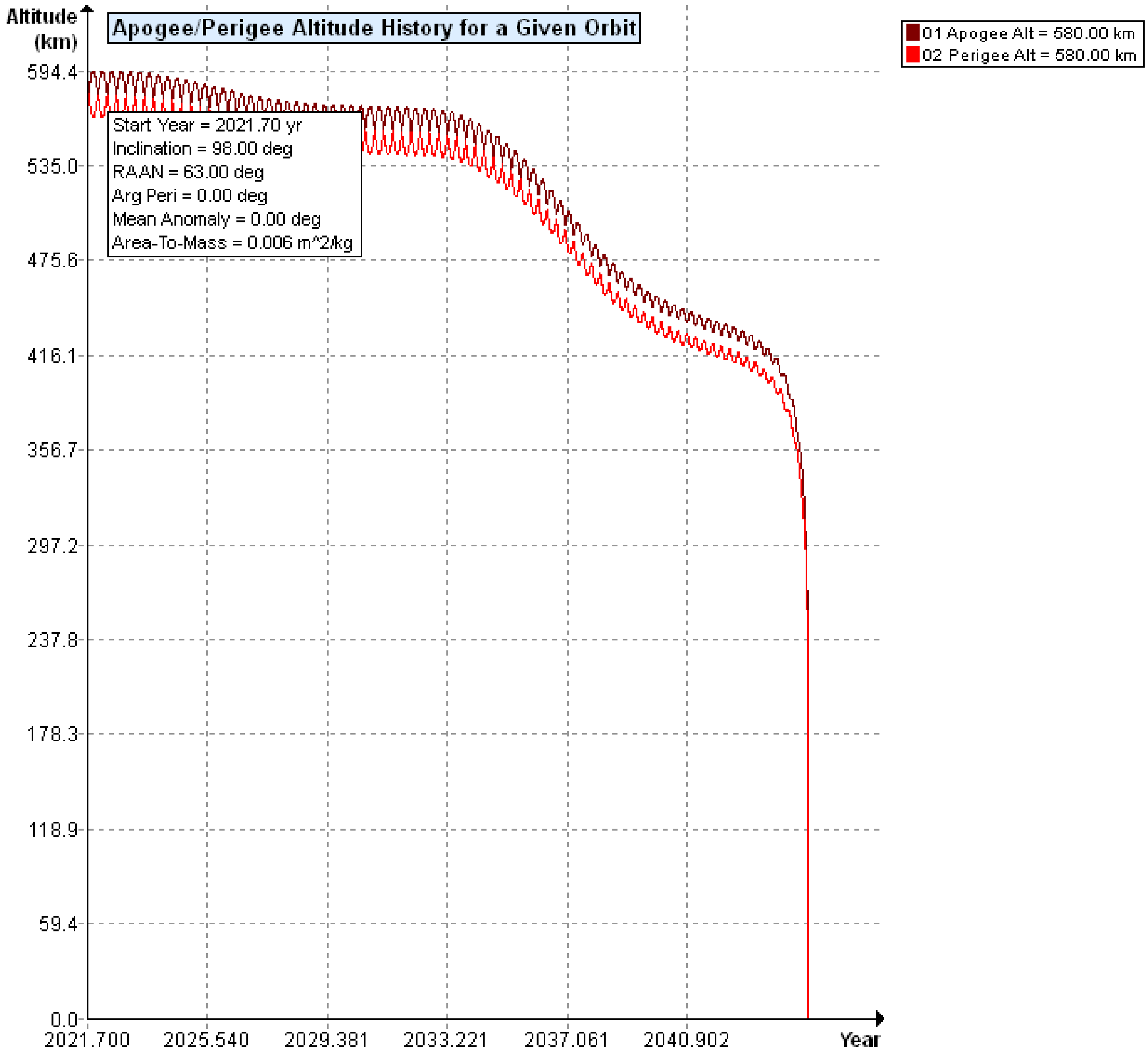
VR-2 Failure at Launch Insertion Orbital Decay (550x550 km)[14]

[13] The VR-2 concept of operations results in a calculated worst case maximum de-orbit life of 22 years.

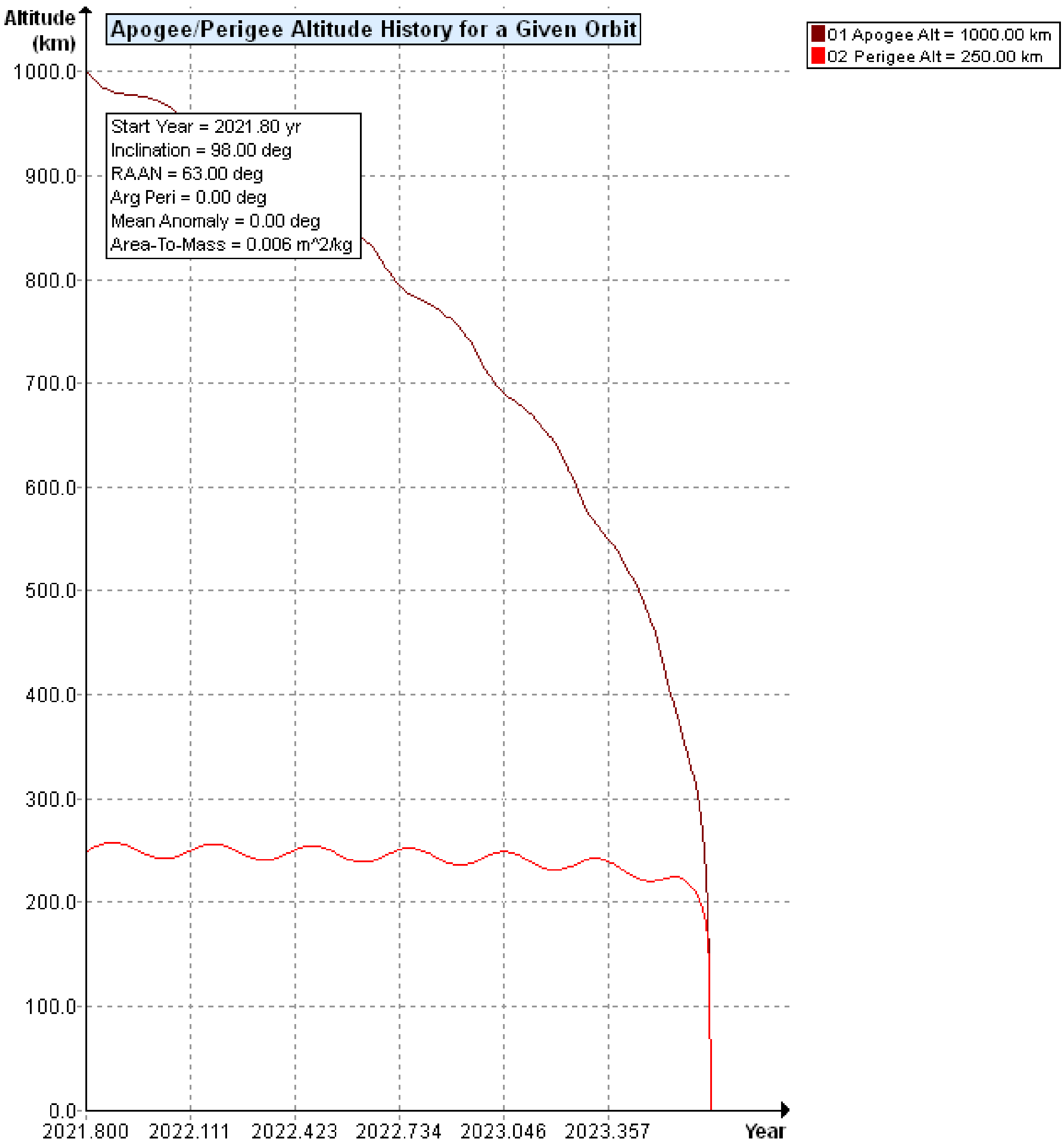
[14] VR-2 has an initial Area-to-Mass ratio of 0.004 m^2/kg prior to deployment of its solar arrays, and a final Area-to-Mass ratio of 0.006 m^2/kg post deployment of its solar arrays (prior to use of propellant and deployment of payloads).



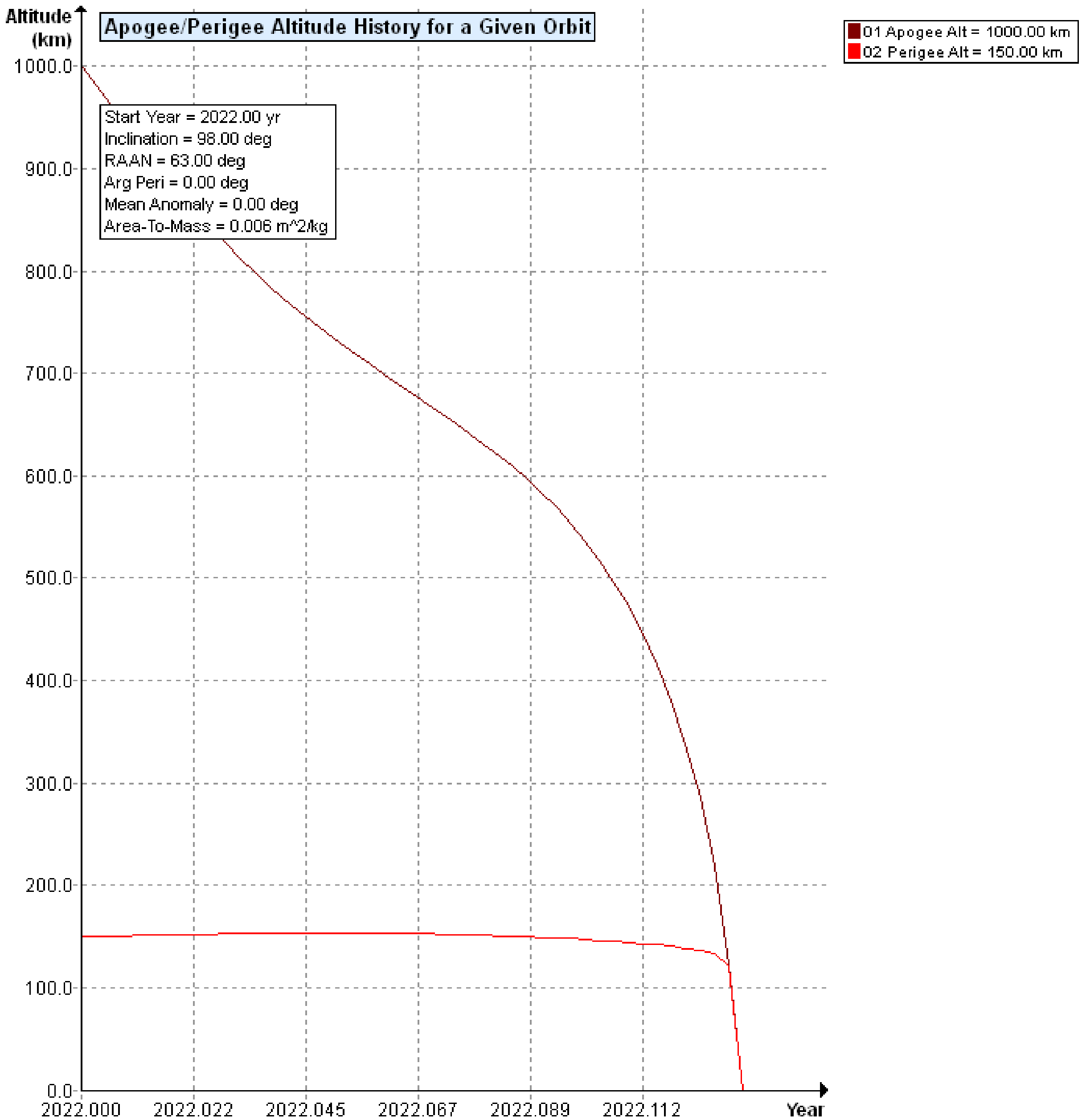
VR-2 Maximum Altitude Failure Orbital Decay (580x580 km)


Altitude (km)
Apogee/Perigee Altitude History for a Given Orbit
01 Apogee Alt = 580.00 km
02 Perigee Alt = 580.00 km
594.4
535.0
475.6
416.1
356.7
297.2
237.8
178.3
118.9
59.4
0.0
Start Year = 2021.70 yr
Inclination = 98.00 deg
RAAN = 63.00 deg
Arg Peri = 0.00 deg
Mean Anomaly = 0.00 deg
Area-To-Mass = 0.006 m^2/kg
2021.700
2025.540
2029.381
2033.221
2037.061
2040.902
Year

VR-2 Postmission De-Orbit Orbital Decay (250x1000 km)



VR-2 Postmission De-Orbit Orbital Decay (150x1000 km)



Requirement 4.6-2. Disposal for space structures near GEO.

- Not applicable.

Requirement 4.6-3. Disposal for space structures between LEO and GEO.

- Not applicable.

Requirement 4.6-4. Reliability of Postmission Disposal Operations

- Not applicable. The satellite will reenter passively without post mission disposal operations within allowable timeframe.

VII. Spacecraft Reentry Hazards

Requirement 4.7-1. Limit the risk of human casualty:

The potential for human casualty is assumed for any object with an impacting kinetic energy in excess of 15 joules:

1. For uncontrolled reentry, the risk of human casualty from surviving debris shall not exceed 0.0001 (1:10,000) (Requirement 56626).

Summary Analysis Results: DAS v3.1.0 reports that VR-2 is compliant with the requirement with a 1:100000000 risk of human casualty. As shown below, six VR-2 components may survive re-entry.

Analysis using DAS v3.1.0:

02 09 2021; 10:41:35AM Processing Requirement 4.3-2: Return Status : Passed

=====================

No Project Data Available

=====================

=============== End of Requirement 4.3-2 ===============

02 09 2021; 11:03:58AM Processing Requirement 4.5-1: Return Status : Passed

==============

Run Data

==============

INPUT

Space Structure Name = Vigoride-2

Space Structure Type = Payload

Perigee Altitude = 550.000 (km)

Apogee Altitude = 550.000 (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 = 469.000 (kg)

Final Mass = 469.000 (kg)

Duration = 0.500 (yr)

Station-Kept = False

Abandoned = True

OUTPUT

Collision Probability = 8.7272E-05

Returned Message: Normal Processing

Date Range Message: Normal Date Range

Status = Pass

==============

============== End of Requirement 4.5-1 ===============

02 09 2021; 11:04:38AM Project Data Saved To File

02 09 2021; 11:04:38AM Project Data Saved To File

02 09 2021; 11:06:49AM Requirement 4.5-2: Compliant

==

Spacecraft = Vigoride-2

Critical Surface = Avionics

==

INPUT

Apogee Altitude = 550.000 (km)

Perigee Altitude = 550.000 (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 = 469.000 (kg)

Final Mass = 469.000 (kg)

Station Kept = No

Start Year = 2021.600 (yr)

Duration = 0.500 (yr)

Orientation = Random Tumbling

CS Areal Density = 5.000 (g/cm^2)

CS Surface Area = 1.0000 (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: 50.000 (cm)

OUTPUT

Probability of Penetration = 6.6820E-06 (6.6820E-06)

Returned Error Message: Normal Processing

Date Range Error Message: Normal Date Range

=============== End of Requirement 4.5-2 ===============

02 09 2021; 11:07:06AM   Processing Requirement 4.6 Return Status : Passed

==============

Project Data

==============

INPUT

Space Structure Name = Vigoride-2

Space Structure Type = Payload

Perigee Altitude = 550.000000 (km)

Apogee Altitude = 550.000000 (km)

Inclination = 98.000000 (deg)

RAAN = 0.000000 (deg)

Argument of Perigee = 0.000000 (deg)

Mean Anomaly = 0.000000 (deg)

Area-To-Mass Ratio = 0.004000 (m^2/kg)

Start Year = 2021.600000 (yr)

Initial Mass = 469.000000 (kg)

Final Mass = 469.000000 (kg)

Duration = 0.500000 (yr)

Station Kept = False

Abandoned = True

PMD Perigee Altitude = 537.987723 (km)

PMD Apogee Altitude = 561.508014 (km)

PMD Inclination = 98.020358 (deg)

PMD RAAN = 189.177848 (deg)

PMD Argument of Perigee = 51.219772 (deg)

PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Suggested Perigee Altitude = 537.987723 (km)

Suggested Apogee Altitude = 561.508014 (km)

Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2042 (yr)

Requirement = 61

Compliance Status = Pass

==============

=============== End of Requirement 4.6 ===============

02 09 2021; 11:08:19AM *********Processing Requirement 4.7-1

Return Status : Passed

***********INPUT****

Item Number = 1

name = Vigoride-2

quantity = 1

parent = 0

materialID = 8

type = Box

Aero Mass = 469.000000

Thermal Mass = 469.000000

Diameter/Width = 1.200000

Length = 1.200000

Height = 1.100000

name = Primary Radiator Segment

quantity = 4

parent = 1

materialID = 8

type = Flat Plate

Aero Mass = 3.500000

Thermal Mass = 3.500000

Diameter/Width = 0.400000

Length = 0.400000

name = Secondary Radiator

quantity = 1

parent = 1

materialID = 8

type = Flat Plate

Aero Mass = 3.400000

Thermal Mass = 3.400000

Diameter/Width = 0.500000

Length = 0.500000

name = Side Radiator Plate

quantity = 2

parent = 1

materialID = 8

type = Flat Plate

Aero Mass = 6.000000

Thermal Mass = 6.000000

Diameter/Width = 0.350000

Length = 1.200000

name = Corner Brackets

quantity = 4

parent = 1

materialID = 8

type = Box

Aero Mass = 1.100000

Thermal Mass = 1.100000

Diameter/Width = 0.100000

Length = 0.350000

Height = 0.100000

name = Comms Panel

quantity = 2

parent = 1

materialID = 8

type = Flat Plate

Aero Mass = 1.100000

Thermal Mass = 1.100000

Diameter/Width = 0.150000

Length = 0.350000

name = Lower Payload Deck Segment

quantity = 4

parent = 1

materialID = 8

type = Flat Plate

Aero Mass = 4.500000

Thermal Mass = 4.500000

Diameter/Width = 0.500000

Length = 0.500000

name = Structure

quantity = 1

parent = 1

materialID = 8

type = Box

Aero Mass = 24.000000

Thermal Mass = 24.000000

Diameter/Width = 0.600000

Length = 0.600000

Height = 0.350000

name = Propellant Tanks

quantity = 4

parent = 1

materialID = 8

type = Box

Aero Mass = 9.710000

Thermal Mass = 9.710000

Diameter/Width = 0.300000

Length = 0.350000

Height = 0.300000

name = Launch Vehicle Adapter

quantity = 1

parent = 1

materialID = 8

type = Flat Plate

Aero Mass = 4.000000

Thermal Mass = 4.000000

Diameter/Width = 0.600000

Length = 0.600000

name = Solar Array Panel

quantity = 10

parent = 1

materialID = 8

type = Box

Aero Mass = 2.460000

Thermal Mass = 2.460000

Diameter/Width = 0.350000

Length = 1.100000

Height = 0.020000

name = Battery Assembly

quantity = 2

parent = 1

materialID = 8

type = Box

Aero Mass = 8.000000

Thermal Mass = 8.000000

Diameter/Width = 0.200000

Length = 0.250000

Height = 0.100000

name = Power Supply Unit

quantity = 2

parent = 1

materialID = 8

type = Box

Aero Mass = 1.200000

Thermal Mass = 1.200000

Diameter/Width = 0.100000

Length = 0.250000

Height = 0.050000

name = Microwave Source Box

quantity = 2

parent = 1

materialID = 8

type = Box

Aero Mass = 4.000000

Thermal Mass = 4.000000

Diameter/Width = 0.200000

Length = 0.200000

Height = 0.200000

name = Feed System Box

quantity = 2

parent = 1

materialID = 8

type = Box

Aero Mass = 0.500000

Thermal Mass = 0.500000

Diameter/Width = 0.100000

Length = 0.200000

Height = 0.030000

name = Power Distribution Unit

quantity = 2

parent = 1

materialID = 8

type = Box

Aero Mass = 1.600000

Thermal Mass = 1.600000

Diameter/Width = 0.100000

Length = 0.250000

Height = 0.050000

name = Diaphragm Tank Middle

quantity = 2

parent = 1

materialID = 27

type = Cylinder

Aero Mass = 0.250000

Thermal Mass = 0.250000

Diameter/Width = 0.150000

Length = 0.300000

name = Diaphragm Tank End 1

quantity = 2

parent = 1

materialID = 27

type = Sphere

Aero Mass = 0.100000

Thermal Mass = 0.100000

Diameter/Width = 0.150000

name = Diaphragm Tank End 2

quantity = 2

parent = 1

materialID = 27

type = Sphere

Aero Mass = 0.100000

Thermal Mass = 0.100000

Diameter/Width = 0.150000

name = Diaphragm Tank Liner

quantity = 2

parent = 1

materialID = 8

type = Cylinder

Aero Mass = 1.200000

Thermal Mass = 1.200000

Diameter/Width = 0.200000

Length = 0.200000

name = Plumbing Lines

quantity = 20

parent = 1

materialID = 59

type = Cylinder

Aero Mass = 0.030000

Thermal Mass = 0.030000

Diameter/Width = 0.005000

Length = 0.500000

name = Plumbing Fittings

quantity = 20

parent = 1

materialID = 59

type = Cylinder

Aero Mass = 0.050000

Thermal Mass = 0.050000

Diameter/Width = 0.020000

Length = 0.020000

name = Thruster

quantity = 1

parent = 1

materialID = 58

type = Cylinder

Aero Mass = 1.000000

Thermal Mass = 1.000000

Diameter/Width = 0.100000

Length = 0.070000

name = Window

quantity = 1

parent = 1

materialID = 1

type = Cylinder

Aero Mass = 0.010000

Thermal Mass = 0.010000

Diameter/Width = 0.050000

Length = 0.015000

name = Reaction Control Thruster

quantity = 4

parent = 1

materialID = 59

type = Box

Aero Mass = 0.160000

Thermal Mass = 0.160000

Diameter/Width = 0.050000

Length = 0.050000

Height = 0.040000

name = RCS Fasteners

quantity = 4

parent = 1

materialID = 66

type = Flat Plate

Aero Mass = 0.025000

Thermal Mass = 0.025000

Diameter/Width = 0.060000

Length = 0.060000

name = 12U Cubesat Deployer Dummy

quantity = 3

parent = 1

materialID = 8

type = Box

Aero Mass = 24.000000

Thermal Mass = 24.000000

Diameter/Width = 0.400000

Length = 0.600000

Height = 0.400000

name = 12U Cubesat Deployer

quantity = 1

parent = 1

materialID = 8

type = Box

Aero Mass = 24.000000

Thermal Mass = 24.000000

Diameter/Width = 0.400000

Length = 0.600000

Height = 0.400000

name = 3U Cubesat Deployer

quantity = 1

parent = 1

materialID = 8

type = Box

Aero Mass = 3.000000

Thermal Mass = 3.000000

Diameter/Width = 0.150000

Length = 0.400000

Height = 0.150000

name = PocketPod Deployer

quantity = 2

parent = 1

materialID = 8

type = Box

Aero Mass = 1.400000

Thermal Mass = 1.400000

Diameter/Width = 0.150000

Length = 0.300000

Height = 0.100000

name = Payload Interface Adapter

quantity = 6

parent = 1

materialID = 8

type = Flat Plate

Aero Mass = 1.000000

Thermal Mass = 1.000000

Diameter/Width = 0.200000

Length = 0.300000

name = Structural Fasteners

quantity = 150

parent = 1

materialID = 57

type = Cylinder

Aero Mass = 0.010000

Thermal Mass = 0.010000

Diameter/Width = 0.010000

Length = 0.020000

name = Microwave Filament

quantity = 2

parent = 1

materialID = 43

type = Cylinder

Aero Mass = 0.005000

Thermal Mass = 0.005000

Diameter/Width = 0.010000

Length = 0.010000

*************OUTPUT****

Item Number = 1

name = Vigoride-2

Demise Altitude = 77.995232

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Primary Radiator Segment

Demise Altitude = 70.117363

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Secondary Radiator

Demise Altitude = 71.988213

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Side Radiator Plate

Demise Altitude = 71.699188

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Corner Brackets

Demise Altitude = 75.666748

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Comms Panel

Demise Altitude = 74.052116

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Lower Payload Deck Segment

Demise Altitude = 69.854469

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Structure

Demise Altitude = 58.855957

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Propellant Tanks

Demise Altitude = 68.169449

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Launch Vehicle Adapter

Demise Altitude = 71.952995

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Solar Array Panel

Demise Altitude = 75.749306

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Battery Assembly

Demise Altitude = 60.551094

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Power Supply Unit

Demise Altitude = 73.577438

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Microwave Source Box

Demise Altitude = 69.823349

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Feed System Box

Demise Altitude = 75.365021

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Power Distribution Unit

Demise Altitude = 72.174187

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Diaphragm Tank Middle

Demise Altitude = 0.000000

Debris Casualty Area = 1.319117

Impact Kinetic Energy = 13.946454

****

name = Diaphragm Tank End 1

Demise Altitude = 0.000000

Debris Casualty Area = 1.074385

Impact Kinetic Energy = 10.209753

****

name = Diaphragm Tank End 2

Demise Altitude = 0.000000

Debris Casualty Area = 1.074385

Impact Kinetic Energy = 10.209753

****

name = Diaphragm Tank Liner

Demise Altitude = 75.011131

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Plumbing Lines

Demise Altitude = 77.453949

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Plumbing Fittings

Demise Altitude = 72.493210

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Thruster

Demise Altitude = 65.804382

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Window

Demise Altitude = 0.000000

Debris Casualty Area = 0.393613

Impact Kinetic Energy = 0.854894

****

name = Reaction Control Thruster

Demise Altitude = 70.938477

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = RCS Fasteners

Demise Altitude = 0.000000

Debris Casualty Area = 1.742400

Impact Kinetic Energy = 2.833763

****

name = 12U Cubesat Deployer Dummy

Demise Altitude = 64.922531

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = 12U Cubesat Deployer

Demise Altitude = 64.922531

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = 3U Cubesat Deployer

Demise Altitude = 73.828659

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = PocketPod Deployer

Demise Altitude = 75.000038

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Payload Interface Adapter

Demise Altitude = 74.574310

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Structural Fasteners

Demise Altitude = 75.790543

Debris Casualty Area = 0.000000

Impact Kinetic Energy = 0.000000

****

name = Microwave Filament

Demise Altitude = 0.000000

Debris Casualty Area = 0.744200

Impact Kinetic Energy = 2.287786

****

=============== End of Requirement 4.7-1 ===============

VIII. Tether Missions

Not applicable.