ASTRA

ROCKET 4 PAYLOAD USER'S GUIDE

VERSION 1.1 | NOVEMBER 2022

IMPROVE LIFE ON EARTH FROM SPACE®

For the past six years, we've been working to build a space company unlike any other. On November 20, 2021, we became the fastest privately-funded U.S. launch company to reach orbit — and on March 15, 2022, we delivered our first customer payloads to orbit.

Our goal is to reshape how the space industry works, starting with how we get there. By offering more frequent dedicated launches, Astra expects to enable a wave of innovation in low Earth orbit and improve life on our planet through greater connectivity and more regular observation.

The team we've assembled consists of amazingly talented engineers, designers, fabricators, and operators. We have been fortunate enough to attract some of the most entrepreneurial, creative, and hardest working teammates in the world.

Industry giants and a wave of new startups are racing to create trillions of dollars of new economic activity in space. In 2022 alone, billions have been invested into space companies, many of which intend to disrupt the industry[1]. What these innovators need are more flights taking their satellites precisely where they need to go in space.

Rocket 4 is a key component of Astra's Launch System 2, the next step in our long-term strategy of increasing space accessibility to Improve life on Earth from Space®. We're excited to share these details about our new launch vehicle, and we look forward to serving you on your next mission.

Chris C. Kemp
Founder, Chairman & CEO, Astra

1. *Space Investment Quarterly (Q3 2022)*. Space Capital, October 2022

REVISION HISTORY

DATE	VERSION	NOTES
July 2022	1.0	First Release
November 2022	1.1	Updated Release

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Photo by Brady Kenniston

1 INTRODUCTION

INTRODUCTION

PURPOSE

The intent of this Payload User's Guide is to provide an overview of Astra's Rocket 4 and associated services. This document is for information and planning purposes only and is not intended for detailed design use and does not create any representations and warranties relating to Astra's Rocket 4 or its performance. The design specifications throughout this Payload User's Guide are subject to change. Astra is under no obligation to update the design specifications contained in this Payload User's Guide.

ABOUT ASTRA

Astra was founded in 2016 with the mission to Improve Life on Earth from Space® and we believe that success in our mission will lead to a healthier and more connected planet. What inspires us every day at Astra and what unites us with our customers is our mission. We believe that together we can use space to radically improve our world, making it more sustainable, efficient, and connected.

Today, Astra is primarily focused on increasing access to space, because you can't build a space platform that will Improve Life on Earth from Space® if you can't get to space. While rocket science may be notoriously complicated, economies of scale apply like any other industry. Put simply, if you produce something at higher and higher volumes, regardless of how complex it is, it is easier to reduce the per-unit cost. This is Astra's focus.

To get satellites to space economically, you can either scale up your rocket (and make a really big rocket) or design a rocket that is easy and inexpensive to produce – and scale out your factory to make many smaller rockets. While large reusable rockets are ideal for transporting people and large cargo to space, our customers tell us that the flexibility of getting to the right place in space as quickly as possible, at the lowest possible per-launch cost is what is important to them.

We believe a thriving space economy requires both high-volume small launch and human-rated large launch, and that the lowest-cost leaders in each of these categories will be winners. Since its origination, Astra has pursued a strategy of rapid iteration. We've designed, built, tested and flown four different rocket types over the first five years at Astra.

Our objective is to continue to evolve our launch service offering as the market evolves, such that our rocket will be capable of launching the vast majority of satellites launched over the next decade.

TEAM & FACTORY

Astra's success is a direct result of the dedication, productivity, and focus of each and every one of our employees.

Our employees are committed to a pace of iteration that allows us to learn and improve on our products as quickly as possible. This empowers some of the most talented engineers in the world to repeatedly delight our customers in an unforgiving, technically complex, and constantly evolving environment.

Astra designs and manufactures all of its rockets at its campus in Alameda, CA, where the company recently expanded its footprint to over 225,000 sq. ft. of manufacturing and testing facilities. These co-located, state-of-the art production and testing facilities have allowed Astra to rapidly iterate, reduce dependencies on third-party suppliers, and deliver for customers.

If you have any questions about the content in this user's guide or would like to begin planning your mission with Astra, please contact us.

CONTACT

astra.com
orbit@astra.com

THE ASTRA ADVANTAGE

YOUR SCHEDULE

We designed Launch System 2 specifically to support an increased launch cadence and increase Astra's annual launch availability – up to one per week.

More frequent launches allow you to deploy and maintain your constellation on your schedule – with a partner as dynamic as your business.

YOUR ORBITS

We understand the importance of getting right where you want to be in space – without waiting on rideshares and orbital transfer maneuvers.

Dedicated launches accelerate your path to the specific orbit your mission requires and allow you to start providing services sooner.

A RANGE OF INCLINATIONS

Astra's launch services are currently available from two U.S. spaceports to a broad range of orbital inclinations.

We plan to provide more access to space from more places on Earth – with additional spaceports expected to come online in 2024 & beyond.

BEST-IN-CLASS ECONOMICS

Astra is focused on providing the lowest possible price-per-dedicated launch and providing the most affordable path to custom orbits.

Take advantage of best-in-class launch economics and spend more capital building spacecraft and developing products.

2 ROCKET 4

Photo by Brady Kenniston

ROCKET 4 OVERVIEW

Rocket 4 is an expendable, vertically-launched two stage LOX/kerosene rocket, optimized for reliability and manufacturability, and built to significantly reduce the cost of dedicated orbital launches.

Rocket 4 is the product of extensive learnings that took place during the design, manufacturing, and launch of the prior Rocket 3 series. With much of its architectural heritage coming from the Rocket 3 series, Rocket 4 capitalizes on Astra's existing flight heritage, while fine-tuning the rocket for improved reliability and manufacturability.

Astra has focused on building its rockets using proven and cost-efficient metallic structures, leveraging multi-disciplinary production techniques and eschewing labor- intensive processes such as carbon composite layups. These techniques allow for rapid manufacturing and reduced production costs, which are realized in lower launch costs to customers.

Astra plans to ramp Rocket 4 production in 2024, with the goal of creating increased launch availability by achieving an average weekly launch cadence over the course of the product lifecycle.

ROCKET 4

HEIGHT: 62 ft / 18.9 m
DIAMETER: 72 in / 1.8 m
LIFTOFF MASS: ~66,000 lb

UPPER STAGE

ENGINES: One
PROPELLANT FEED: Turbopump
THRUST: ~6,500 lbf
PROPELLANTS: LOX + RP-1

FAIRING

MAX HEIGHT: 133 in
MAX WIDTH: 67.5 in

PAYLOAD INTERFACE:
Compatible with standard separation systems and custom adapters.

FIRST STAGE

ENGINES: Two
PROPELLANT FEED: Turbopump
MAX THRUST: ~80,000 lbf
PROPELLANTS: LOX + RP-1

FIGURE 1. ROCKET 4 - SUBSYSTEM OVERVIEW

STRUCTURES AND SYSTEMS

The structure of Rocket 4 is built entirely from metal, with design choices optimized to produce rockets efficiently at scale. We focus on simple and proven manufacturing techniques that result in lightweight structures throughout the vehicle: e.g. skin-and-stringers instead of milled isogrid and sheet metal in place of costly additive manufacturing. Throughout the vehicle, we have incorporated mass-saving features such as common dome tank designs and submersed helium tanks.

The first stage consists of two cylindrical tanks, enlarged relative to the Rocket 3 series, but using the same proven design and fabrication approach. The LOX and fuel tank are an aluminum common dome tank set, designed and qualified in-house. The longitudinal seams are friction stir welded and the circumferential seams are TIG welded. The domes are now formed directly from thin sheets of aluminum, and the cylinders are rolled sheet. Helium COPVs are submerged in the fuel tank for packaging efficiency. The tank includes slosh baffles and anti-vortex devices.

The upper stage is now essentially a shorter version of the first stage, utilizing the same welding techniques on a similar architecture, though a number of elements are further weight optimized given the increased weight sensitivity of the stage. Like the first stage, it is a common dome assembly with Helium COPVs submerged in the fuel tank.

FIRST STAGE ENGINE

The Rocket 4 first stage is powered by two turbopump-fed LOX engines, each with an expected maximum sea level liftoff thrust of 40,000 lbf. The engine features a regeneratively-cooled combustion chamber operating at over 1,000 psia chamber pressure which is fed by a turbopump.

Each engine can gimbal to provide vehicle steering and control. Actuation of the Thrust Vector Control actuators is “fueldraulic”, powered by high-pressure fuel tapped off from the main fuel circuit. Fueldraulic actuation simplifies the vehicle as it does not require an external high-pressure or high-voltage source for actuation systems that require significant power. The pyrophoric ignition of the engine is ground-based, eliminating another plumbing system from the vehicle and further reducing cost, weight, and complexity. Astra is developing and qualifying an upgraded derivative of a previously qualified engine for this application.

UPPER STAGE ENGINE

Taking over following stage separation, the upper stage engine is a turbopump-fed engine with a vacuum thrust of approximately 6,500 lbf. The upper stage engine is a high-performance LOX engine that propels the upper stage and payload into orbit. It can be restarted prior to payload deployment to enable upper stage circularization and after payload deployment to lower the upper stage’s orbit. The engine, which is being qualified for Astra’s use, is a derivative of an existing qualified engine.

AVIONICS

The Rocket 4 avionics system is designed from the ground up to be reliable, flexible, and low-cost. All avionics hardware goes through final assembly at our on-site manufacturing facility and undergoes qualification and acceptance testing at our in-house environmental lab. Key elements of the vehicle avionics suite include:

- Flight Safety System
- Vehicle batteries and power distribution system
- Engine controllers
- Guidance computer
- Separation control system
- Instrumentation computer
- Inertial Measurement Unit (IMU)
- GPS
- Radio Frequency (RF) transmitter
- Star tracker

Rocket 4's Flight Safety System is an autonomous flight safety system based on thrust termination of the first stage and upper stage engines. This system is currently undergoing qualification.

3 PERFORMANCE

Photo by John Kraus

PERFORMANCE

PAYLOAD CAPACITY

Rocket 4 is designed for a nominal payload capacity of approximately 500 kilograms to a circular 500 km altitude Sun-synchronous orbit (SSO). We intend to initially operate the vehicle with de-rated engines in order to reduce initial system performance risks and schedule risks. This leads to an introductory payload capacity in 2024 of approximately 350 kilograms to a circular 500 km altitude Sun-synchronous orbit. The expected and initial de-rated 2024 payload capacities for additional inclinations are provided in the table below.

As we gain data from ground testing and our early flights, we expect to reduce the engine de-rating which will increase the payload capacity of our launch vehicle. For more information about timing of future increased payload capacity, please contact us.

	LEO	MID	SSO
2024	550 kg	450 kg	350 kg
CONTACT TO BOOK	700 kg	600 kg	500 kg
	10° — 300 km	50° — 500 km	98° — 500 km

THESE FIGURES REPRESENT FORECASTED CAPACITIES THAT ARE EXPECTED TO IMPROVE OVER TIME. PLEASE REACH OUT FOR PAYLOADS THAT ARE ABOVE THE CURRENT PROJECTED CAPACITY FOR A GIVEN TIMEFRAME.

TABLE 1. PAYLOAD CAPACITY TO VARIOUS INCLINATIONS

AVAILABLE ORBITS

Astra currently launches from two locations:

FIGURE 2. ASTRA'S KODIAK LAUNCH SITE

Pad LP-3B at Pacific Spaceport Complex - Alaska (PSCA) in Kodiak, Alaska.

From Pad LP-3B, Rocket 4 can access orbital inclinations ranging from 59° to 110°.

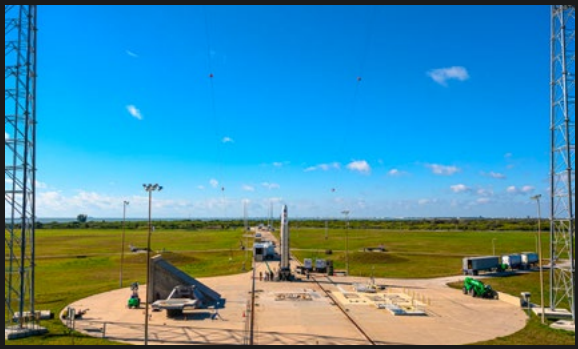

FIGURE 3. SLC46 AT CAPE CANAVERAL SPACE FORCE STATION

SLC46 at Cape Canaveral Space Force Station in Florida.

From SLC46, Rocket 4 can access orbital inclinations ranging from 29° to 59°.

We plan to continue providing more access to space from more places on Earth — with additional spaceports expected to come online in 2024 and beyond.

INJECTION ACCURACY

Rocket 4 is expected to be capable of achieving the following injection accuracies for a typical mission. These are estimates, and we expect to refine these estimates as we obtain additional flight data.

Mission-specific accuracies are provided as part of the mission interface control document (ICD).

PARAMETER	ACCURACY
Perigee	± 10 km
Apogee	± 10 km
Inclination	± 0.15 deg

TABLE 2. INJECTION ACCURACY

ATTITUDE/DEPLOYMENT RATE

Rocket 4's separation attitude tolerances and the attitude rate tolerances at the time of commanded payload deployment are displayed in the table below. Mission-specific accuracies are provided as part of the mission interface control document (ICD).

PARAMETER	ACCURACY (PER AXIS)
Attitude (Roll, Pitch, Yaw)	± 10 deg
Attitude Rates	± 1.5 deg/s

TABLE 3. ATTITUDE AND ATTITUDE RATES ACCURACY

4 ENVIRONMENTS

Photo by John Kraus

ENVIRONMENTS

The following environmental estimates are informed by both analyses and actual payload environments during flight. Please contact us if you have any questions about payload environments.

TEMPERATURE, HUMIDITY, AND CLEANLINESS

Astra provides conditioned environments for both payload integration and pre-launch operations. Environments are monitored continuously, and any deviations are reported to the customer through an automated alert system.

	TEMP. (°F)	HUMIDITY	CLEANLINESS
TRANSPORTATION	70 ± 9	0% to 70%	Class 100,000 (ISO 8)
STORAGE	70 ± 9	0% to 70%	Class 100,000 (ISO 8)
PAYLOAD PROCESSING	70 ± 9	30% to 70%	Class 100,000 (ISO 8)
ROCKET INTEGRATION	70 ± 9	0% to 70%	Class 100,000 (ISO 8)

TABLE 4. PAYLOAD INTEGRATION AND PRE-LAUNCH ENVIRONMENTS

Payload integration nominally takes place within a cleanroom at Astra's headquarters in Alameda, California. We can also accommodate a cleanroom at the launch site as needed. After integration and encapsulation is complete, the payload assembly is purged with dry, filtered air through integration with the rocket, and up until launch to maintain environments listed in the PUG. Humidity may drop to 0%. Payload purge is maintained until lift-off of the launch vehicle.

Astra provides a payload integration environment that complies with ISO 8 (class 100,000) cleanliness requirements. Following payload integration and fairing encapsulation, the fairing is purged with dry, filtered air to maintain the ISO 8 / class 100,000 environment.

	MAXIMUM AIRBORNE HYDROCARBON CONTENT	ELECTROSTATIC DISCHARGE
TRANSPORTATION	15 ppm by volume	Class 1A
STORAGE	15 ppm by volume	Class 1A
PAYLOAD PROCESSING	15 ppm by volume	Class 1A
ROCKET INTEGRATION	15 ppm by volume	Class 1A

TABLE 5. PAYLOAD INTEGRATION AND PRE-LAUNCH ENVIRONMENTS (2)

During flight, the payload experiences a free molecular heating rate no greater than 1135 W/m^2. The greatest heating rate occurs immediately following fairing separation. The sequence of GNC mission events is tailored as part of the mission analysis, in particular the timing of fairing separation, to ensure this limit is not exceeded.

COORDINATE SYSTEM

All loads are given according to the following coordinate system:

- +X runs along the axis of the vehicle, pointing towards the nose
- +Y points to the right, when the vehicle is horizontal and viewed from the nose
- +Z is directly upwards when the vehicle is horizontal

ACCELERATION LOADS

Payloads will experience a range of acceleration loads during flight, which are bounded according to the graph below. The peak longitudinal quasi-static acceleration occurs at first stage nominal burnout. If a lower peak acceleration is required given specific payload structural limits, If stricter acceleration requirements are needed, please contact Astra for more details. Mission-specific accelerations will be further defined in the mission-specific ICD informed by the coupled loads analysis.

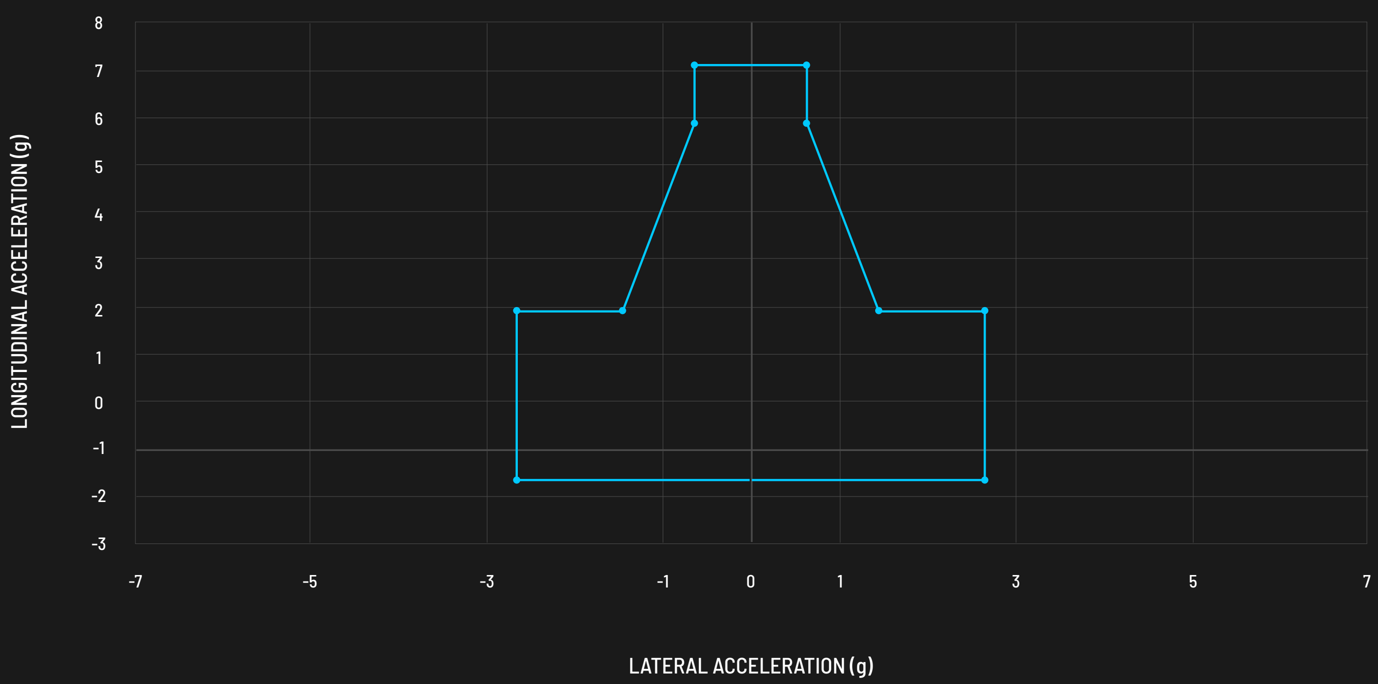

FIGURE 4. QUASI-STATIC LOAD BOX

RANDOM VIBRATION

The estimated Rocket 4 random vibration curve is based on an analysis of vehicle environments and is subject to change with additional flight information and testing. Rocket 4's random vibration estimates are enveloped by the NASA GEVS 10 GRMS curve, both shown below.

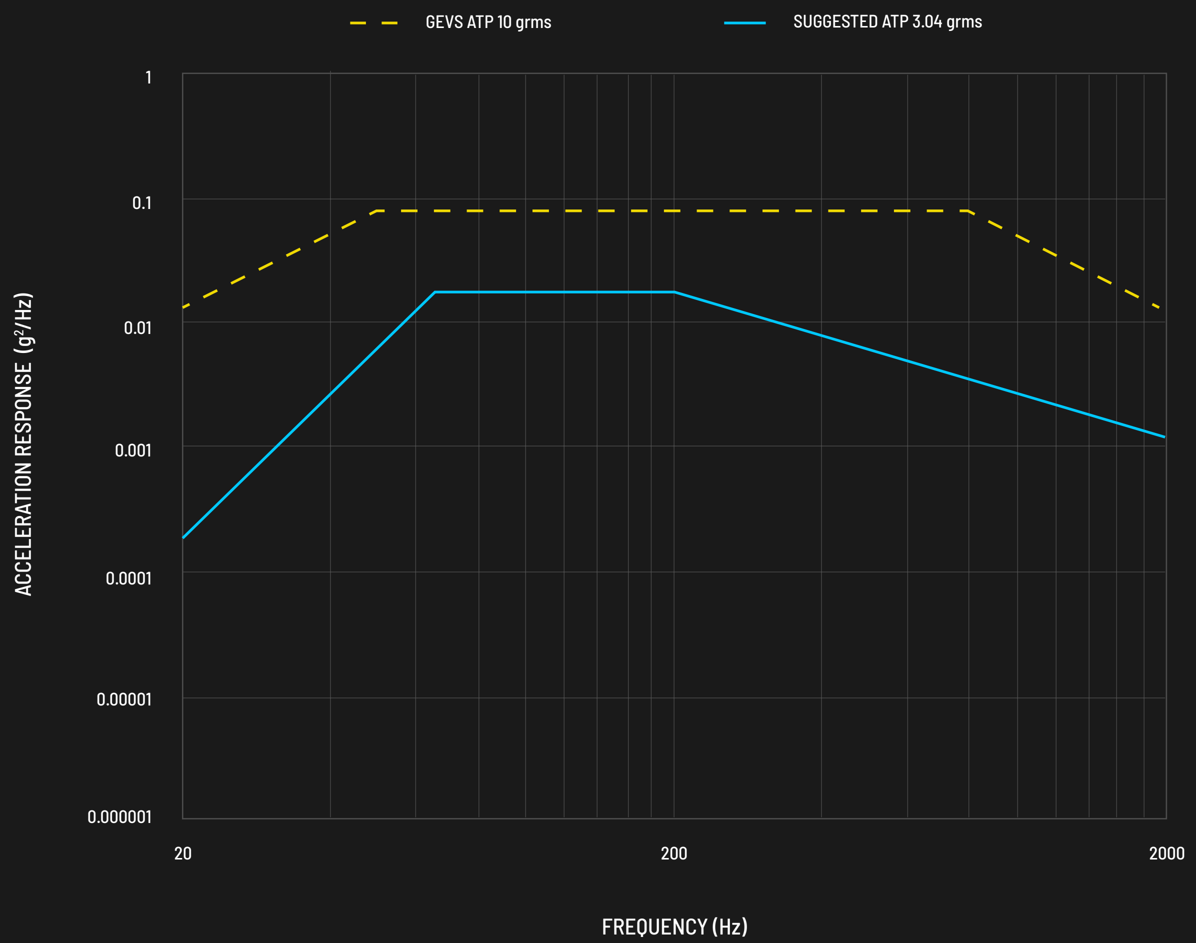

FIGURE 5. RANDOM VIBRATIONS

FREQUENCY (Hz)	MAXIMUM PREDICTED ENVIRONMENT + 3dB (g^2/Hz)
20	0.000168
65	0.017090
200	0.017089885
2000	0.001225427

TABLE 6. RANDOM VIBRATIONS

ACOUSTICS

The maximum predicted payload acoustic environment is shown below. This environment is based on an equal combination of analysis and data measured from the first stage engine. The acoustic environment is driven by the liftoff, and transonic and max dynamic pressure phases of flight. These are subject to change.

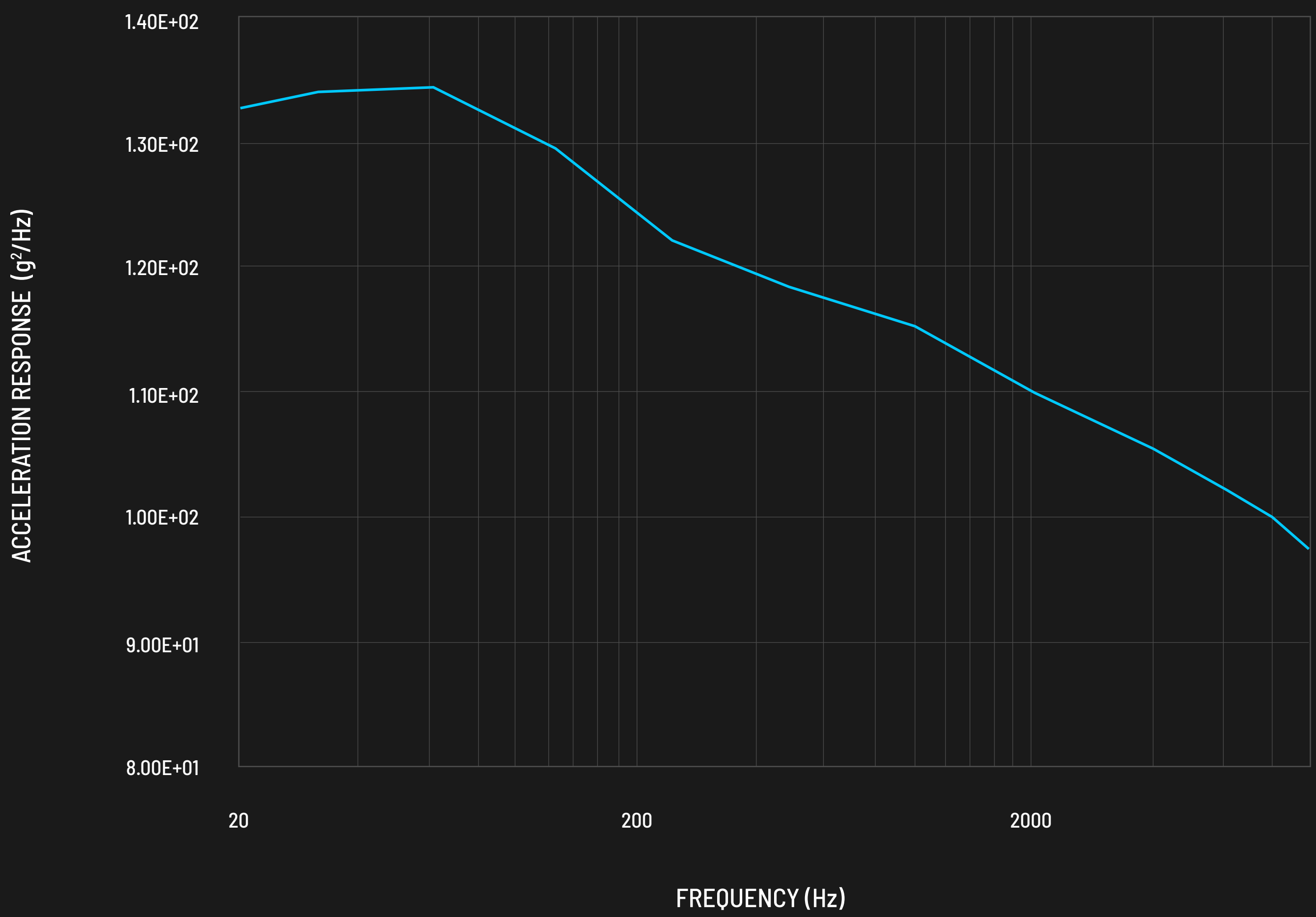

FIGURE 6. MAXIMUM PREDICTED ACOUSTIC ENVIRONMENT

OCTAVE BAND FREQUENCY (Hz)	SOUND PRESSURE LEVEL (MPE + 3dB [OASPL = 139.1dB])
15.6	131.9
31.3	133.9
62.5	134.4
125	129.6
250	122.1
500	118.2
1000	115.3
2000	110
4000	105.5
8000	100.1
16000	91.8

TABLE 7. MAXIMUM PREDICTED ACOUSTIC ENVIRONMENT

SHOCK

The main source of shock from the vehicle occurs from the non-pyrotechnic separation devices at lift-off and stage separation. The maximum predicted Shock Response Spectrum is shown below. This is an estimate based on current vehicle configuration and analysis.

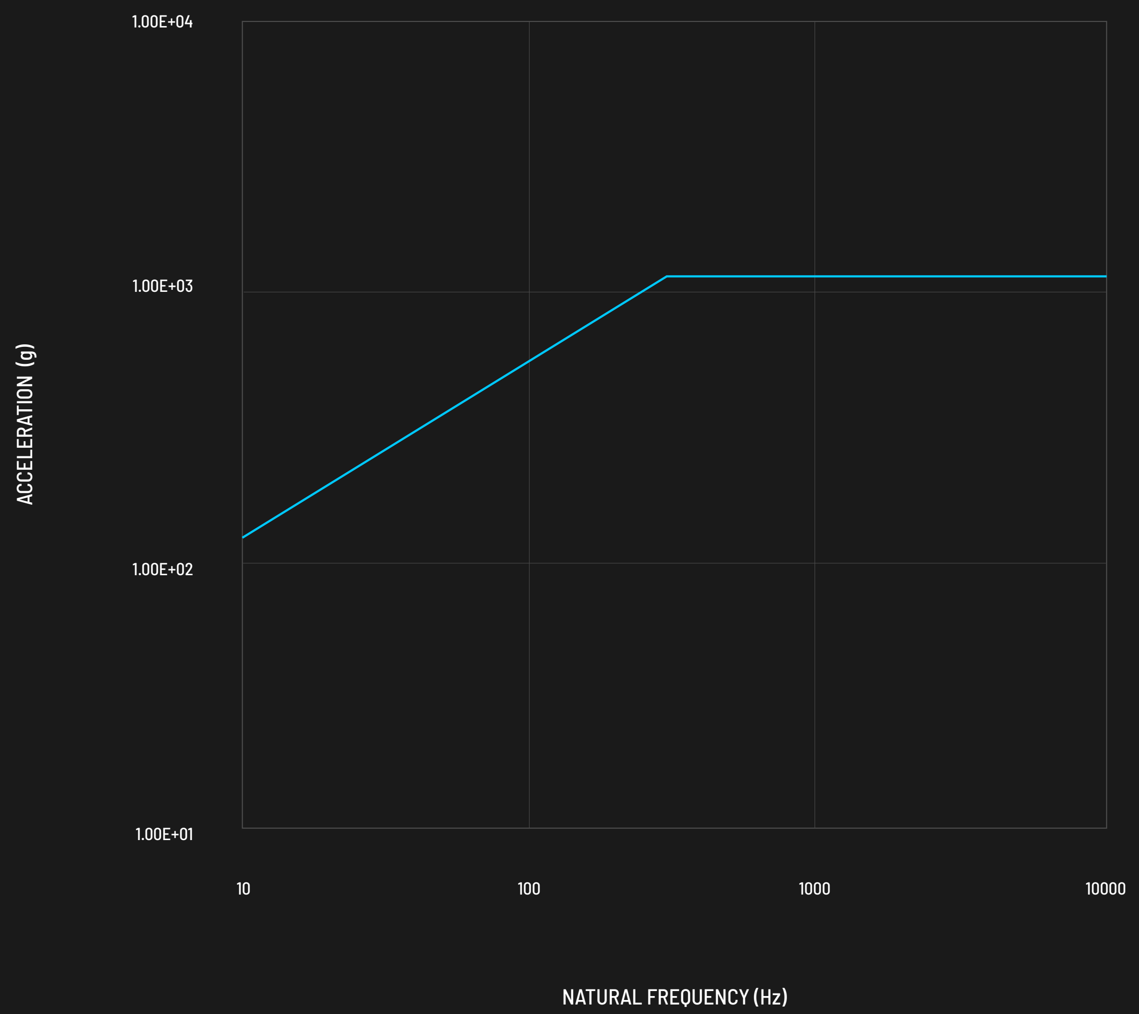

FIGURE 7. MAXIMUM PREDICTED SHOCK RESPONSE SPECTRUM

TABLE 8. MAXIMUM PREDICTED SHOCK RESPONSE SPECTRUM

FREQUENCY (Hz)	SHOCK MPE LEVEL (g)
10	120
300	1150
10000	1150

RADIO FREQUENCY TRANSMISSION

During flight, payloads are nominally powered off and not transmitting. If your payload requires an exception, please contact us for more information. The table below shows worst case radiated environments for Rocket 4.

FREQUENCY RANGE (MHz)	E-FIELD LIMIT (dBµV/m)	
1 - 1600	90	
1600 - 1650	146	Satellite-based Telemetry
1625 - 2200	90	
2200 - 2300	146	S-band Telemetry
2300 - 18000	90	

TABLE 9. WORST CASE RADIATED ENVIRONMENTS FOR ROCKET 4

FREQUENCY RANGE (MHz)	E-FIELD LIMIT (dBµV/m)	
1 - 1565	120	
1565 - 1585	48	GPS L1
1585 - 18000	120	

TABLE 10. MAXIMUM SPACECRAFT (PAYLOAD) EMISSIONS

FAIRING INTERNAL PRESSURE VENTING

The maximum depressurization rate of the payload bay is 0.5 psi/second, which occurs during the transonic portion of flight.

ENVIRONMENTAL COMPATIBILITY

Payloads must be certified to be compatible with the environments listed in this document. Astra will provide more information about this process as we discuss your mission-specific requirements.

5 INTERFACES

Photo by John Kraus

INTERFACES

Astra develops an Interface Control Document (ICD) unique to each mission's requirements in conjunction with the customer. This document outlines how the payload fits within, attaches to, and deploys from the launch vehicle.

USABLE FAIRING VOLUME

Rocket 4's usable fairing volume is given below (in inches). As we evolve our launch vehicle, we are also evolving the size of our payload fairing. For information about fairing sizes in 2024 and later, please contact us.

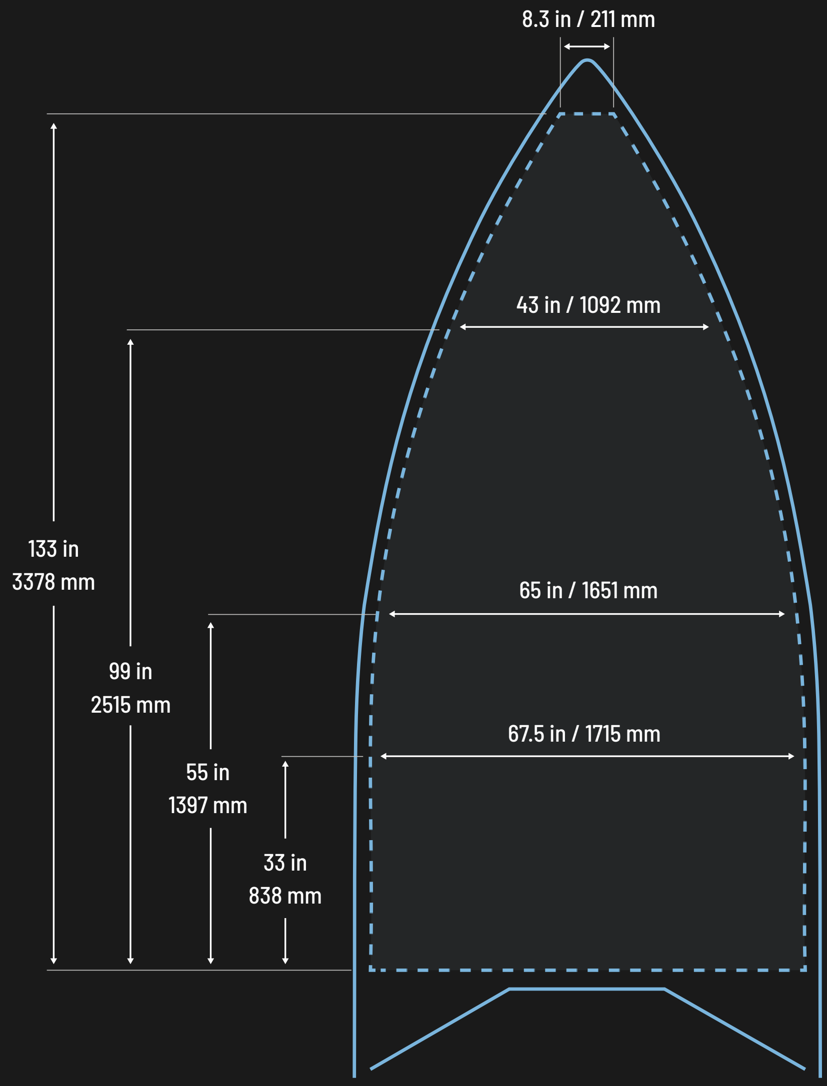

FIGURE 8.
ROCKET 4 PAYLOAD FAIRING USABLE VOLUME

MECHANICAL INTERFACES AND PAYLOAD DEPLOYMENT

Rocket 4 will be configurable with two standard payload attach fittings to serve a single ESPA Grande payload or two ESPA standard payloads. Secondary payload adapters can be utilized to serve multi-manifest missions (e.g. multiple cube sat dispensers for a rideshare mission) which are customized with an interface bolt pattern based on customer mission requirements. As a non-standard service, Astra is also able to design custom adapters if the footprint of the payload plate is insufficient to accommodate the desired payload interfaces.

We offer the ability for payload integration to take place at the launch site, and can also provide the Rocket 4 payload adapter plate to the customer for the customer to complete integration at their own facility, separate from the launch vehicle.

Please contact us for any assistance in selecting a separation system, or for confirmation that we can support your chosen deployer hardware.

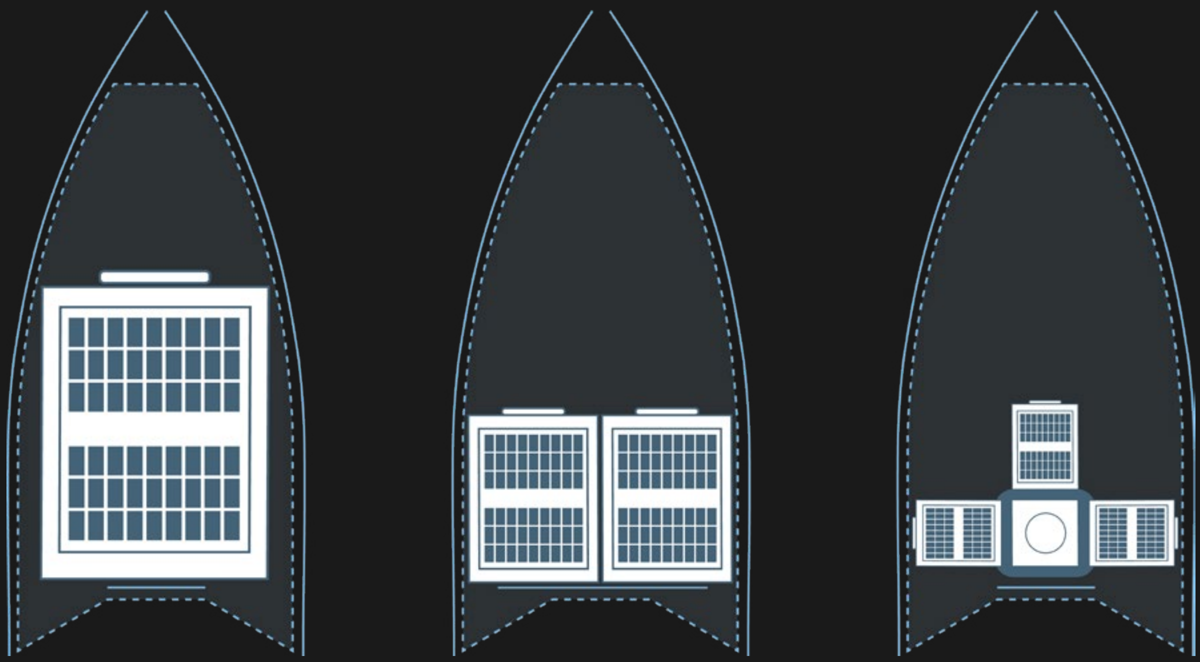

FIGURE 9.
ROCKET 4 PAYLOAD CONFIGURATION EXAMPLES

ELECTRICAL INTERFACES

Astra provides a common electrical interface that can easily be adapted to a wide number of payloads and separation systems. The standard interface sends redundant payload deployment signals and receives deployment feedback signals, which are reported via telemetry.

Further details on the electrical interface will be provided in the mission-specific Interface Control Document. Additional electrical accommodations are possible as a non-standard service.

6

PAYLOAD & LAUNCH OPERATIONS

Photo by Brady Kenniston

PAYLOAD & LAUNCH OPERATIONS

Astra is working to make orbital launch quicker, simpler, and easier than ever.

STANDARD SERVICES

As part of any launch service, Astra will:

- Provide a mission manager
- Provide regular coordination teleconferences with the customer
- Conduct a trajectory and performance analysis
- Coordinate the payload safety approval process with the FAA in support of a launch license
- Secure third-party liability insurance for the launch vehicle
- Develop an Interface Control Document (ICD) in conjunction with the customer
- Receive and integrate the payload in Alameda
- Ensure an ISO-8 cleanliness level during payload processing and up to launch
- Conduct an orbital launch and provide required signals for spacecraft separation
- Provide confirmation of spacecraft separation and state vector
- Provide post-flight report summary

NON-STANDARD SERVICES

Astra is happy to work with customers to provide the following non-standard services:

- Payload fueling
- Astra-provided payload deployer(s)
- Additional electrical accommodations for the payload
- Additional acoustic protection for the payload
- Maintain an ISO-7 or better cleanliness level for payload processing and launch
- Non-standard security requirements
- Responsive launch capability
- Additional mission assurance reviews

Please contact us for more information regarding any other services not listed above that you require for your mission.

FIGURE 10. PAYLOAD INTEGRATION

PAYLOAD PROCESSING

The customer payload experience begins with payload delivery and integration into the rocket. Standard payload integration occurs at Alameda inside an environmentally controlled cleanroom to ISO 8 standards. Astra can also provide cleanroom facilities and integration at the launch site, if requested.

In addition to cleanroom space, we provide the following for customers:

- A standard set of tools, as well as any tools specifically requested by the customer or already present in our factory
- Desk space, office supplies, and amenities
- Cleanroom PPE and cleaning supplies
- Standard industrial gasses and compressed gas handling equipment
- Standard electrical checkout equipment

Astra can support loading non-toxic propellants at the launch site as a non-standard service.

FIGURE 11. MISSION CONTROL IN ALAMEDA, CA

MISSION TIMELINE

The following timeline shows the milestones and deliverables between Astra and the customer for a typical mission (assumes launch site payload integration). Accelerated or extended timelines are possible, and mission-specific milestones will be developed in conjunction with the customer as part of finalizing the Scope of Work.

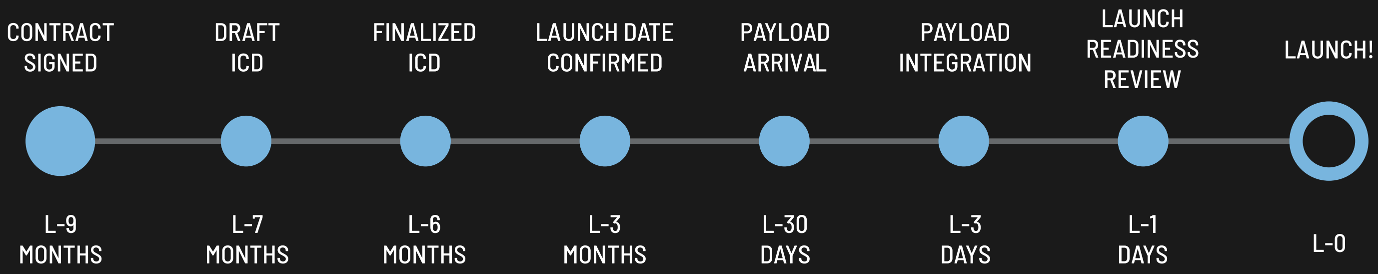

FIGURE 12. STANDARD MISSION MILESTONE SCHEDULE

DATE	ASTRA DELIVERABLES	CUSTOMER DELIVERABLES
L-215		Payload CAD model Preliminary mass properties Handling and other requirements
L-210	Draft ICD	
L-200	Preliminary trajectory and performance analysis	
L-180	Final ICD	Final mass properties & launch inputs*
L-90	Required test & analyses per ICD Preliminary integration procedures	Payload license & safety documentation Environmental and mass certifications Checkout procedures
L-60	ICD verifications Final payload integration procedures Launch date confirmation	ICD verifications Payload Readiness Review
L-30		Payload arrival at Alameda
L-10	Vehicle arrival at the launch site	
L-2 OR 3	Payload integration and subsequent servicing up until launch	Customer support for payload integration*
L-1	Launch Readiness Review	Launch Readiness Review
L-0	Launch	
T+60 MINUTES	Confirmation of deployment and provision of state vector	

TABLE 11. STANDARD SCHEDULE FOR ASTRA AND CUSTOMER DELIVERABLES

**IF REQUIRED*

(SCHEDULE TAILORED PER MISSION)

SAMPLE MISSION PROFILE

The table below shows the approximate profile of a direct injection Rocket 4 mission. Mission timelines are dependent on the payload and targeted orbit, and will be developed specifically for your mission.

TIME	ACTIVITY
T-0	Liftoff
T+74 seconds	Max-q
T+168 seconds	Main engine cutoff (MECO)
T+173 seconds	Stage separation
T+177 seconds	Second stage ignition
T+231 seconds	Fairing separation
T+535 seconds	Second engine cutoff (SECO) 1
T+3252 seconds	Circularization burn
T+3258 seconds	SECO 2
Mission dependant	Payload Deployment
Mission dependant	Stage Disposal

TABLE 12. STANDARD FLIGHT MILESTONES

RAPID RESPONSIVE LAUNCH

Rocket 4 and its ground support infrastructure have been designed from the beginning to be mass-manufacturable and rapidly deployable. The launch vehicle and ground support equipment (GSE) are sized to fit within ISO standard shipping containers or to be handled via standard ISO means.

This mobile launch system allows for Rocket 4 to be launched from a multitude of launch sites[2] (with minimal existing launch infrastructure required) and achieve a wide range of low-earth altitudes, inclinations, and LTANs/LTDNs. Rocket 4 can be rapidly deployed to support missions that require responsive launch capabilities[3].

FIGURE 13.
ASTRA'S ROCKET 3.3 LAUNCH VEHICLE IS UNLOADED FROM ITS CONTAINER IN CAPE CANAVERAL

FIGURE 14.
INFRASTRUCTURE IS SHIPPED TO THE LAUNCH SITE VIA PLANE, TRUCK, OR BOAT

2. As of November 12, 2022, Astra has two launch sites, and expects to have at least one additional launch site in 2024.
3. Subject to launch date availability at the launch site chosen to support your mission.

7 FACILITIES

Photo by John Kraus

FACILITIES

Our Alameda, California campus has 225,000 square feet of combined manufacturing, testing, integration, and office space. Physical security is present 365 days a year with 52 cameras for site monitoring and live footage capture. Additionally, our campus is compliant with all ITAR physical security requirements.

FIGURE 15. ASTRA'S SKYHAWK DEVELOPMENT AND MANUFACTURING FACILITY

FIGURE 16. TEST CELL AT ORION ENGINE TESTING FACILITY

FIGURE 17. PAD B AT PACIFIC SPACEPORT COMPLEX - KODIAK, ALASKA

FIGURE 18. SLC46 AT CAPE CANAVERAL SPACE FORCE STATION - CAPE CANAVERAL, FLORIDA

SECURITY

At Pacific Spaceport Complex - Alaska (PSCA), the launch pad is secured with fence and a gate that requires badge access. Security checkpoints are established on launch days. Astra has a standard launch site security procedure and additional security can be contracted as required.

Cape Canaveral is a secure military facility with armed guards and patrolled by military personnel 24/7. There are checkpoints at all entrances that prevent unauthorized visitors and only allow visitors if they're badged. The launch pad itself is enclosed by a fence on the secure military base

Additional security can be contracted as required.

APPENDIX

LIST OF ACRONYMS

AFSS	Autonomous Flight Safety System
ASD	Acceleration Spectral Density
ATP	Acceptance Test Procedure
CA	California
CG	Center of Gravity
FAA	Federal Aviation Administration
GEVS	General Environment Verification Standard
GRMS	Root Mean Square Acceleration
GSE	Ground Support Equipment
ICD	Interface Control Document
ISO	International Organization for Standardization
LOX	Liquid Oxygen
LRR	Launch Readiness Review
LTAN	Longitude of the Ascending Node
LTDN	Longitude of the Descending Node
MPE	Maximum Predicted Environment
PPE	Personal Protective Equipment
PSCA	Pacific Spaceport Complex - Alaska
PSD	Power Spectral Density
RF	Radio Frequency
SL	Sea Level
SRS	Shock Response Spectrum
SSO	Sun-Synchronous Orbit

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