NEUTRON

PAYLOAD USER'S GUIDE

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Rocket Lab USA, Inc.
rocketlabusa.com

ROCKETLAB

CONTENTS

1.0 INTRODUCTION 4

1.1 Introduction 5

1.2 About Rocket Lab 5

1.3 Neutron Overview 6

2.0 NEUTRON LAUNCH VEHICLE OVERVIEW 8

2.1 Neutron First Stage 9

2.2 Neutron Second Stage 10

2.3 Archimedes Engine 11

2.4 Reusability 13

2.5 Avionics & Guidance, Navigation, and Control 13

2.5.1. Autonomous Flight Safety System (AFSS) 13

2.6 Neutron Safety 14

2.6.1 Safety Requirements 14

2.7 Managing Hazards 14

2.7.1 Waivers 14

2.8 Pricing 14

3.0 PERFORMANCE 15

3.1 Performance 16

3.2 Mass-To-Orbit Capability 17

3.3 Flight Attitude 18

3.4 Orbital Injection Accuracy 18

3.5 Separation Attitude and Accuracy 18

3.6 Mission Profiles 19

4.0 PAYLOAD ACCOMODATION 21

4.1 Payload Interface Control Document (ICD) 22

4.2 Neutron Coordinate Frame 22

4.3. Payload Accommodation 23

4.4. Payload Support Structure 24

4.5 Payload Electrical Interfaces 25

4.6 Payload Mechanical Interfaces 25

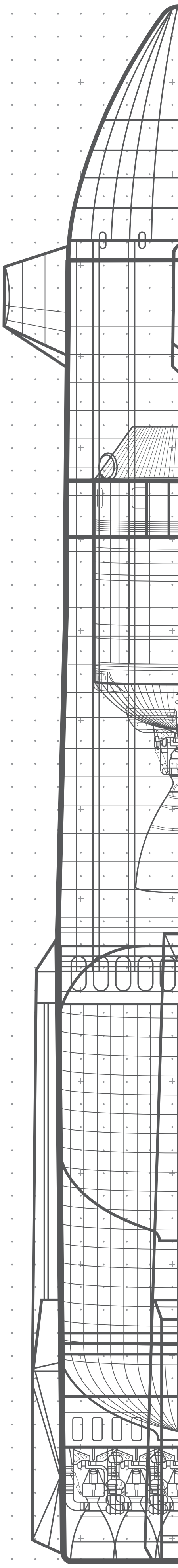
CONTENTS

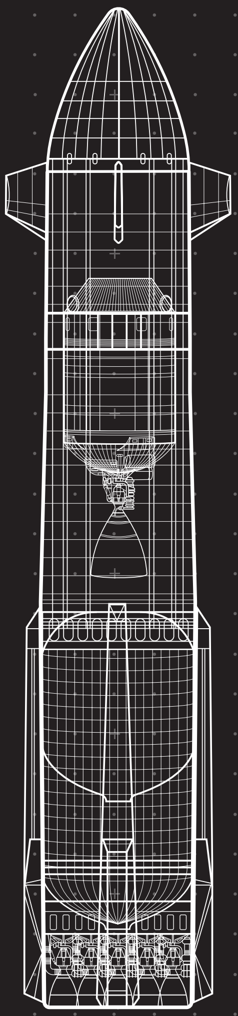
5.0 ENVIRONMENTS 26
5.1 Pre-Launch Environments 27
5.1.1. Transportation Environment 27
5.1.2 Cleanliness, Temperature, and Humidity 27
5.1.3 Ground System Gas Delivery 28
5.2 Flight Environments 28
5.2.1 Acceleration loads 28
5.2.2 Shock 30
5.2.3 Acoustics 31
5.2.4 Temperature 33
5.2.5 EMI/EMC 34
5.2.6 Venting 35

6.0 ROCKET LAB FACILITIES 36
6.1 Rocket Lab Launch Complex 3 – Virginia 37
6.1.1 Neutron Assembly and Integration Complex - Virginia 38
6.1.2 Mid-Atlantic Regional Spaceport Payload Processing Facility 38
6.1.3 Customer Facilities & Access 39
6.2 Space Structures Complex - Maryland 39
6.3 Stennis Test Complex - Mississippi 39
6.4 Rocket Lab Headquarters - California 40
6.4.1 Engine Development Complex - California 40

7.0 LAUNCH OPERATIONS 41
7.1 Pre-launch Operations 42
7.1.1 Integration Operations 43
7.1.2 Payload Processing 44
7.1.3 Transporatation 45
7.2 Launch Operations 46
7.2.1. Recycle and scrub 47
7.3. Post launch reporting 47
7.4 Launch Operational Safety 47

8.0 DOCUMENT REFERENCES 48
8.1 List Of Figures 48
8.2 List Of Tables 49
8.3 List Of Acronyms 49





SECTION

1.0

INTRODUCTION

1.1
Introduction

The Neutron Payload User's Guide is presented as an introduction to the launch services available on Rocket Lab's Neutron launch vehicle.

This Payload User's Guide has been developed for pre-contract mission planning only. Information and data for mission design purposes will be exchanged directly between Rocket Lab customers and a Rocket Lab mission manager. Rocket Lab reserves the right to update this Payload User's Guide as required.

1.2
About Rocket Lab

Founded in 2006, Rocket Lab is an end-to-end space company with an established track record of mission success. Rocket Lab delivers reliable launch services, satellite manufacture, spacecraft components, and on-orbit management solutions that make it faster, easier, and more affordable to access space. Headquartered in Long Beach, California, Rocket Lab designs and manufactures the Electron small orbital launch vehicle, a family of flight proven spacecraft, and is developing the Neutron launch vehicle, a medium-lift rocket that is expected to become the world's largest carbon composite orbital launch vehicle. Since its first orbital launch in January 2018, Rocket Lab's Electron launch vehicle has become the second most frequently launched U.S. rocket annually and has delivered satellites to orbit for private and public sector organizations, enabling operations in national security, scientific research, space debris mitigation, Earth observation, climate monitoring, and communications. Rocket Lab's family of spacecraft have been selected to support U.S. civil and defense missions, as well as the first private commercial mission to Venus. Rocket Lab has four launch pads at three launch sites, including a dedicated launch and landing pad for Neutron located in Virginia. Rocket Lab has been publicly traded on the Nasdaq (RKLB) since August 2021.

1.3

Neutron Overview

Figure 1 | Neutron Launch Vehicle

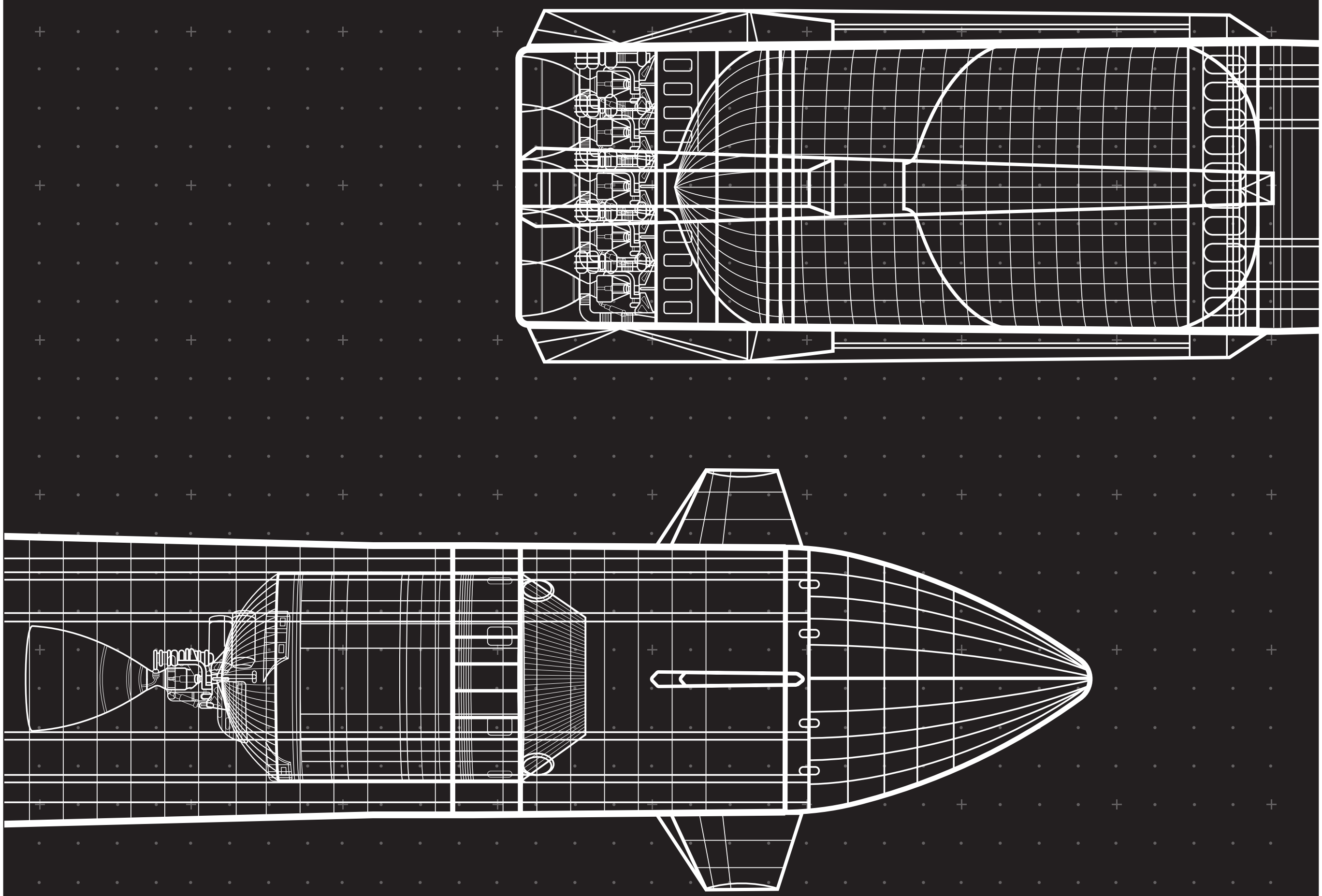
Neutron is a medium-lift reusable orbital launch vehicle designed to deliver a cost-effective, reliable, responsive, and frequent launch service that meets customers' needs (Figure 1). Neutron can accommodate single satellite and multi-satellite constellation deployment, high-assurance payloads, and cargo to various Earth orbits, as well as lunar and interplanetary destinations. Neutron's expected performance is up to 13,000 kg (13 metric tonnes) to low-Earth orbit; 15,000 kg (15 metric tonnes) for expendable missions; and up to 2,000 kg to the Moon (2 metric tonnes) on a trans-lunar injection.

Neutron is a two-stage launch vehicle that stands 43-meters (141 feet) tall with a 7-meter (22.9 ft) diameter. Neutron features a Neutron fully reusable first stage designed to return to the launch site or land on an ocean platform, including a reusable fairing that remains attached to the launch vehicle's first stage when it returns to Earth. Its fairing diameter is 5.5-meters (18 ft).

Neutron is powered by nine Archimedes engines on the first stage and a single vacuum-optimized relightable Archimedes engine on the second stage. The launch vehicle utilizes advanced carbon composite technology throughout many of its structures to provide additional performance, including its first and second stages and propellant tanks, making it the world's largest reusable carbon composite launch vehicle.

Neutron is developed, manufactured, and tested across Rocket Lab's facilities throughout the United States. These include the Engine Development Complex in Long Beach, California, where Rocket Lab's Headquarters are located; its engine test facility at NASA's John C. Stennis Space Center in Hancock County, Mississippi; its Space Structures Complex in Middle River, Maryland; and its Neutron Assembly and Integration Complex on Wallops Island, Virginia. Neutron will launch and land at Rocket Lab's Launch Complex 3 on Wallops Island, Virginia.


NEUTRON
Payload Adapter
SECOND STAGE
One Archimedes Engine
Two-Petal Captive Fairing
Four Canards
ROCKETLAB
NEUTRON
FIRST STAGE
Landing Gear
Nine Archimedes Engines



SECTION

2.0

NEUTRON LAUNCH VEHICLE OVERVIEW

2.1

Neutron First Stage

Neutron's first stage (Stage 1) is entirely reusable and made of carbon composite. It consists of nine sea-level Archimedes engine with common bulkhead tanks for its Liquid Oxygen (LOx) and Methane propellants, and a captive fairing.

The complete Neutron launch vehicle pictured in Figure 1 returns to the landing site as a single assembly, including an extended interstage assembly and the captive payload fairings (Figure 3). The Stage 1 has a tapered profile and aerodynamic control surfaces, including forward canards and landing legs, that act as lifting bodies during descent. Combined with a low ballistic coefficient that reduces aerothermal loading, these features allow Neutron's Stage 1 to glide back to Earth for landing. The Stage 1's thrust structure is coated in a thermal efficient and reusable Thermal Protection System (TPS) to resist the high heat re-entry environment, a technology to recover composite-structure boosters from near-orbital velocities that has been developed and flight-proven on the Electron launch vehicle.

Figure 2 | Neutron First Stage With Captive Fairing

2.2

Neutron Second Stage (Stage 2)

Neutron's second stage (Stage 2) is made of carbon composite and consists of a single vacuum-optimized Archimedes engine and common bulkhead tanks for its LOx and Methane propellants.

It is produced to be extremely mass-efficient and cost-optimized, as it is expended every launch, and is capable of multiple re-lights for constellation deployment and extended on-orbit operations.

Encapsulated and "hung" within Neutron's Stage 1, the Stage 2 (Figure 3) is suspended by its top flange inside the interstage at a rigid mounting interface. In addition to providing easily accessible and condensed mounting location for avionics hardware, aerodynamic control devices, and fluids lines, this interface also minimizes the requirement for the Stage 2 to withstand the external launch environment during ascent.

Driven by a pneumatic impulse delivery system, Neutron's Stage 2 separates quickly to maintain high performance while keeping shock and acceleration loads to a minimum. The internal travel of the Stage 2 ensures tipoff rates are low during deployment and eliminates payload recontact concerns.

Figure 3 | Neutron Stage 2 + Payload

2.3

Archimedes Engine

Neutron is powered by the Archimedes engine, an oxidizer-rich staged combustion cycle engine that will power the reusable Stage 1 and expendable Stage 2 of the launch vehicle (Figure 4).

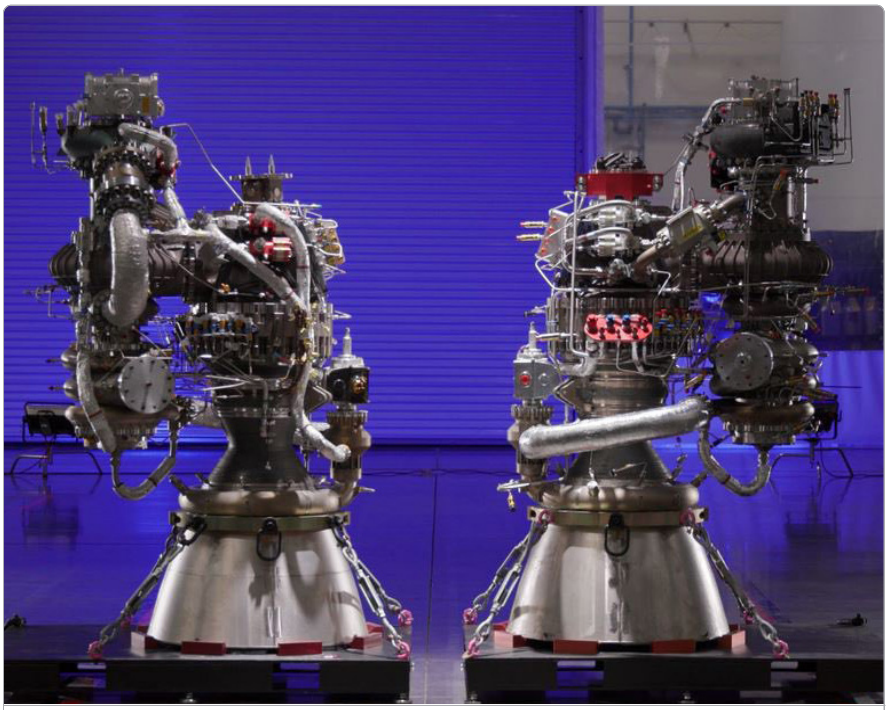


Figure 4 | Archimedes Engines In Production At Rocket Lab's Engine Development Complex

Capable of producing up to 165,000 (733 kilonewtons) pounds of thrust (lbf) per engine, Archimedes operates at lower stress levels than other rocket engines to enable rapid and reliable reusability. The combined thrust of nine Archimedes engines for Neutron's Stage 1 is designed to reach 1,450,000 lbf total. Each engine burns Liquid Methane and Liquid Oxygen, which provides higher specific impulse than RP-1 kerosene for improved stage performance without the dramatic stage size increase required for low density Liquid Hydrogen. Archimedes operates on an Oxidizer Rich Staged Combustion (ORSC) cycle, which provides higher specific impulse than open cycles such as gas generator, open expander, or tapoff cycles, without the thrust limits inherent to the closed expander cycle or the added complexity of the full flow staged combustion cycle. The engine is operated at a relatively benign statepoint that reduces the challenges associated with high pressure oxygen compatibility and high temperature turbine drive gas. The lower thermal strains across the engine improve life and reusability of the engine. The engine consists of a single shaft turbopump design, with the fuel pre-burner stacked on top of the turbine, which is connected via a shaft to the Liquid Oxygen pump and Liquid Methane pumps, enhancing overall packaging. Many of its critical components are 3D printed including Archimedes' turbo pump housings, pre-burner and main chamber components, valve housings, and engine structural components.

The engine is designed and manufactured in the United States at Rocket Lab's Engine Development Complex in Long Beach, California prior to testing at NASA's John C. Stennis Space Center. The engine is manufactured through a combination of additive manufacturing and traditional manufacturing techniques. Additive manufacturing allows optimized mechanical designs and fluid pathways with significant part count reduction, while conventional manufacturing allows higher mechanical properties and lower total cost for some components.

Table 1 | Neutron Launch Vehicle Characteristics

CHARACTERISTIC	FIRST STAGE	SECOND STAGE
STRUCTURE		
Height	42.8 m	11.5 m
Diameter	7 m	4.9 m
Type	Pressurized structures – Monocoque	Pressurized structures – Monocoque
Material	Carbon Fiber Reinforced Polymer	Carbon Fiber Reinforced Polymer
PROPULSION		
Engine designation	Archimedes	Archimedes Vacuum
Engine type	Oxidizer Rich Staged Combustion	Oxidizer Rich Staged Combustion, Vacuum Optimized
Engine designer	Rocket Lab	Rocket Lab
Engine manufacturer	Rocket Lab	Rocket Lab
Number of engines	9	1
Propellant	Liquid Methane/Liquid Oxygen	Liquid Methane/Liquid Oxygen
Thrust (stage total)	6600 kN, Sea Level	900 kN, Vacuum
Propellant feed system	Turbopump	Turbopump
Throttle capability	65% Minimum	65% Minimum
Restart capability	Yes	Yes
ASCENT ATTITUDE CONTROL		
Pitch, yaw	Gimbaled Engines	Gimbaled Engine
Roll	Gimbaled Engines	Cold Gas Thrusters
Coast attitude control	Cold Gas Thrusters	Cold Gas Thrusters
OPERATIONS		
Shutdown process	Commanded on achieving required state vector (Delta-V)	Commanded on achieving precise state vector or Minimum Residuals (for maximum performance)
Stage separation system	Pneumatic	N/A
Fairing	Retained on Stage	N/A

2.4
Reusability

Neutron's Stage 1 is entirely reusable, including the captive payload fairing, while the Stage 2 is produced to be extremely mass-efficient and cost-optimized, as it is expended every launch.

There are two reusable mission profiles possible with Neutron. The first is a Return To Launch Site (RTLS) mission profile where, after Stage 2 separation, Neutron's Stage 1 reorients itself to return to Earth at Rocket Lab Launch Complex 3 in Virginia, U.S. Neutron can also perform a down range landing (DRL) maneuver that incorporates a precision landing at sea onto a marine system that allows Rocket Lab to maximize the vehicle's performance during flight (Figure 5).

Figure 5 | Render Of A Neutron Down Range Landing (DRL) Maneuver

2.5
Avionics & Guidance, Navigation, and Control

Neutron's avionics consist of distributed command and data handling, radio communications, auxiliary monitoring, navigation sensors, and an independent autonomous flight safety system (AFSS). Each stage flies itself using independent flight computers, alongside remote I/O consolidation connected by high-speed networks. Multiple S-band radio frequency (RF) transceivers on each stage provide high-bandwidth links for telemetry and video. Rocket Lab also offers deployment video capabilities, with additional RF bandwidth available based on mission specific requirements.

Avionics validation is performed at both the component level and through Rocket Lab's hardware-in-the-loop (HITL) test facility which allows for integrated launch vehicle and software simulation and testing.

2.5.1
Autonomous Flight Safety System (AFSS)

The Neutron launch vehicle's autonomous flight safety system (AFSS) independently monitors progress, continuously comparing the vehicle state against a set of mission rules, through over-the-horizon tracking capabilities. This allows for faster response times and improved monitoring as the launch vehicle travels downrange, without the limitations of line-of-sight tracking required by ground-based instrumentation.

2.6
Neutron Safety

Neutron commercial missions are authorized by the Federal Aviation Administration (FAA) under Part 450 Launch and Re-entry License.

2.6.1
Safety Requirements

Neutron safety and reliability goals comply with National Security Space Launch (NSSL) and other necessary certification requirements, ensuring high mission assurance for all customers. Rocket Lab achieves this, in part, by complying with the requirements for the safety of people and property as defined by GSFC-STD-8009, Wallops Flight Facility Range Safety Manual. All hazardous vehicle and ground support systems used during launch processing are designed, implemented, tested, and operated in accordance with this standard.

Payloads and their launch ground support will also be required to meet the intent of GSFC-STD-8009, Wallops Flight Facility Range Safety Manual. Rocket Lab will assist customers through this tailoring process.

2.7
Managing Hazards

Hazardous systems and operations typically include chemical, electrical, lifting, mechanical, ordnance, pressurized, propulsion/propellant, and RF/radiation systems. Rocket Lab follows the systems safety approach defined by MIL-STD 882E, U.S. Department of Defense Standard Practice System Safety for identifying and managing hazards to an acceptable level of safety risk. Safety risks are reduced through following the hierarchy of controls: elimination of hazards, substitution of hazards, engineering controls, administrative controls, and personal protective equipment.

Customers are also expected to manage safety risks associated with their payload and its ground support equipment. Details of hazardous payload and ground support systems will be required as part of the range safety approval process.

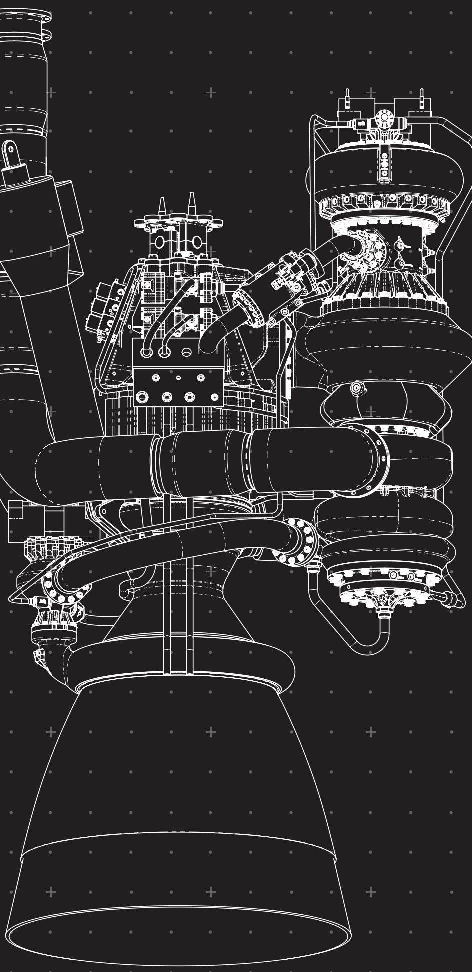
2.7.1
Waivers

Waivers are not considered standard practice.

2.8
Pricing

For quotes tailored to your mission, contact: **launch@rocketlabusa.com**

or visit www.rocketlabusa.com/book-my-launch



SECTION

3.0

PERFORMANCE

3.1

Performance

Neutron builds on the heritage of Electron launch vehicle, which has launched 50+ times and deployed 200+ payloads.

Rocket Lab has carried forward flight-proven design approaches such as carbon composite tanks, avionics systems, and validation and verification approaches to reduce program risk and time to market. This also extends to launch vehicle performance-modeling and analysis approaches, providing strong confidence in achieving the mass to orbit, accuracy probability, and confidence parameter requirements that are demanded by customers. In addition to rigorous analysis, the Neutron program has utilized a hardware-rich development approach early in the vehicle design lifecycle, which mitigates analysis risk significantly by anchoring preliminary performance models to reality, yielding accurate predictions for first flight. To further mitigate performance risk, ample conservatism is built into performance models and dispersions until system test is achieved or flight data is captured.

Neutron's performance modelling to date accounts for low- through to high-inclination orbits and sun-synchronous orbits (SSO). Neutron is built for high injection accuracy, with the vehicle's Stage 2 capable of a direct-injection or multi-plane delivery. Neutron launches are tailored to the mission requirements of each customer – contact Rocket Lab for more information.

3.2

Mass-To-Orbit Capability

Rocket Lab's Neutron launch vehicle, when launching from Rocket Lab Launch Complex 3 at the Mid-Atlantic Regional Spaceport (MARS) on Wallops Island, Virginia, U.S., is capable of three trajectory types, describing the action of the Stage 1: Return to Launch Site (RTLS), Down Range Landing (DRL), or Expendable. A summary of available Neutron capabilities is provided below in Table 2. For performance estimates to a specific orbit, please contact **launch@rocketlabusa.com.**

Table 2 | Neutron Mass To Orbit Capability

MTO (KG)	MID-INC (40°)	POLAR (90°)	GEOSTATIONARY TRANSFER ORBIT (GTO) (40°)
RTLS	8,500	6,200	N/A
DRL	13,000	10,100	1,800
Expendable	15,000	11,800	2,800

*Assumes a 500km circular orbit for Mid-Inc and Polar.

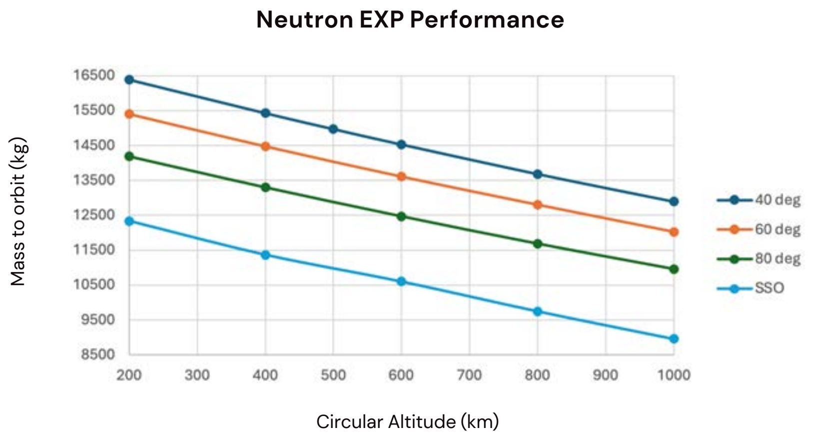


Figure 6 | Neutron Expendable (EXP) Performance

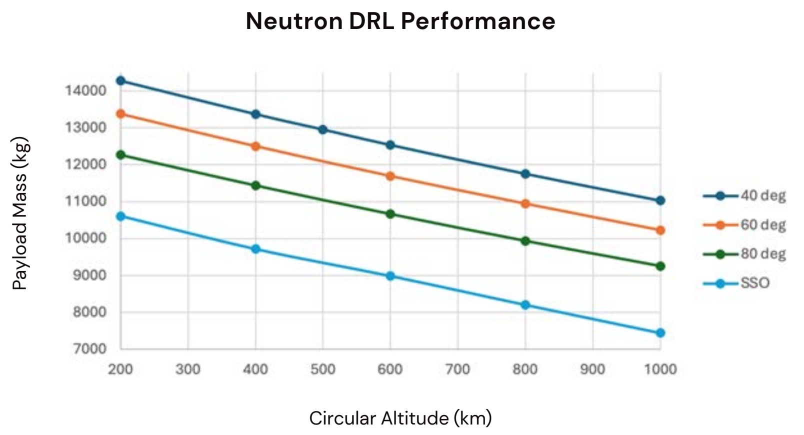


Figure 7 | Neutron Down Range Landing (DRL) Performance

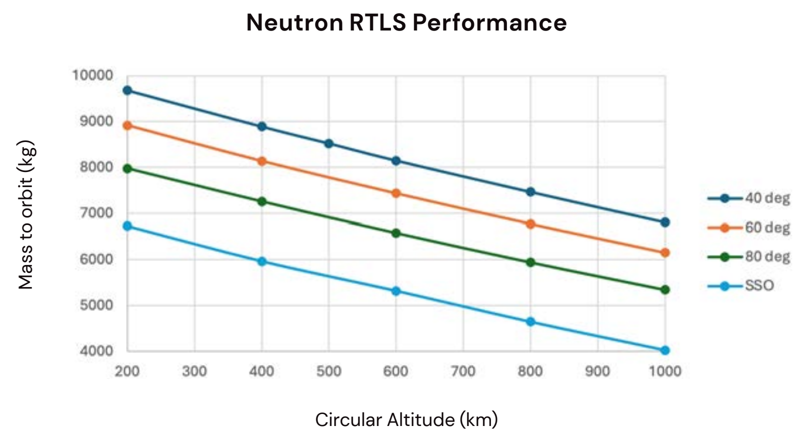


Figure 8 | Neutron Return-To-Launch-Site (RTLS) Performance

3.3

Flight Attitude

If required, the attitude reaction control system onboard the launch vehicle's Stage 2 will enable long-duration coast missions through a commanded roll rate. The passive thermal control roll rate is provided around the y-axis, between 0.5 deg/sec and 2 deg/sec, ensuring control of satellite thermal boundaries.

3.4

Orbital Injection Accuracy

Neutron can achieve the following injection accuracies for a typical 500km circular orbit. Mission-specific accuracies are calculated as part of Neutron mission analysis.

Table 3 | Neutron Orbital Injection Accuracy Performance

INCLINATION	±0.15 degrees
PERIGEE	±15 km
APOGEE	±15 km

3.5

Separation Attitude and Accuracy

The attitude reaction control system onboard Neutron's s Stage 2 will provide the capability to hold a nominal attitude prior to separation of the payload, resulting in low deployment attitude error and rate margins. Mission-specific values will be provided by Rocket Lab as part of Neutron mission analysis.

Table 4 | Neutron Separation Attitude Accuracy Performance

ATTITUDE	±5 degrees/second
RATES	±1.5 degrees/second

3.6
Mission Profiles

Neutron launch services are provided from Rocket Lab's domestic launch facility on Wallops Island, Virginia.

Located at Virginia Spaceport Authority's (VSA) Mid-Atlantic Regional Spaceport (MARS), Rocket Lab Launch Complex 3 (LC-3) is a dedicated facility for Neutron launch, land, and test, and represents a new national launch capability for the United States. Designed to support rapid call-up missions, LC-3 delivers responsive launch capability from home soil for U.S. Government and commercial satellites.

Alongside the capability to support a wide range of orbital inclinations, LC-3 supports all three Neutron flight profiles with the addition of a landing pad and marine systems. An example flight profile for a Neutron mission from LC-3 is shown below in Return To Launch Site (RTLS), Down Range Landing (DRL), and Expendable configurations.

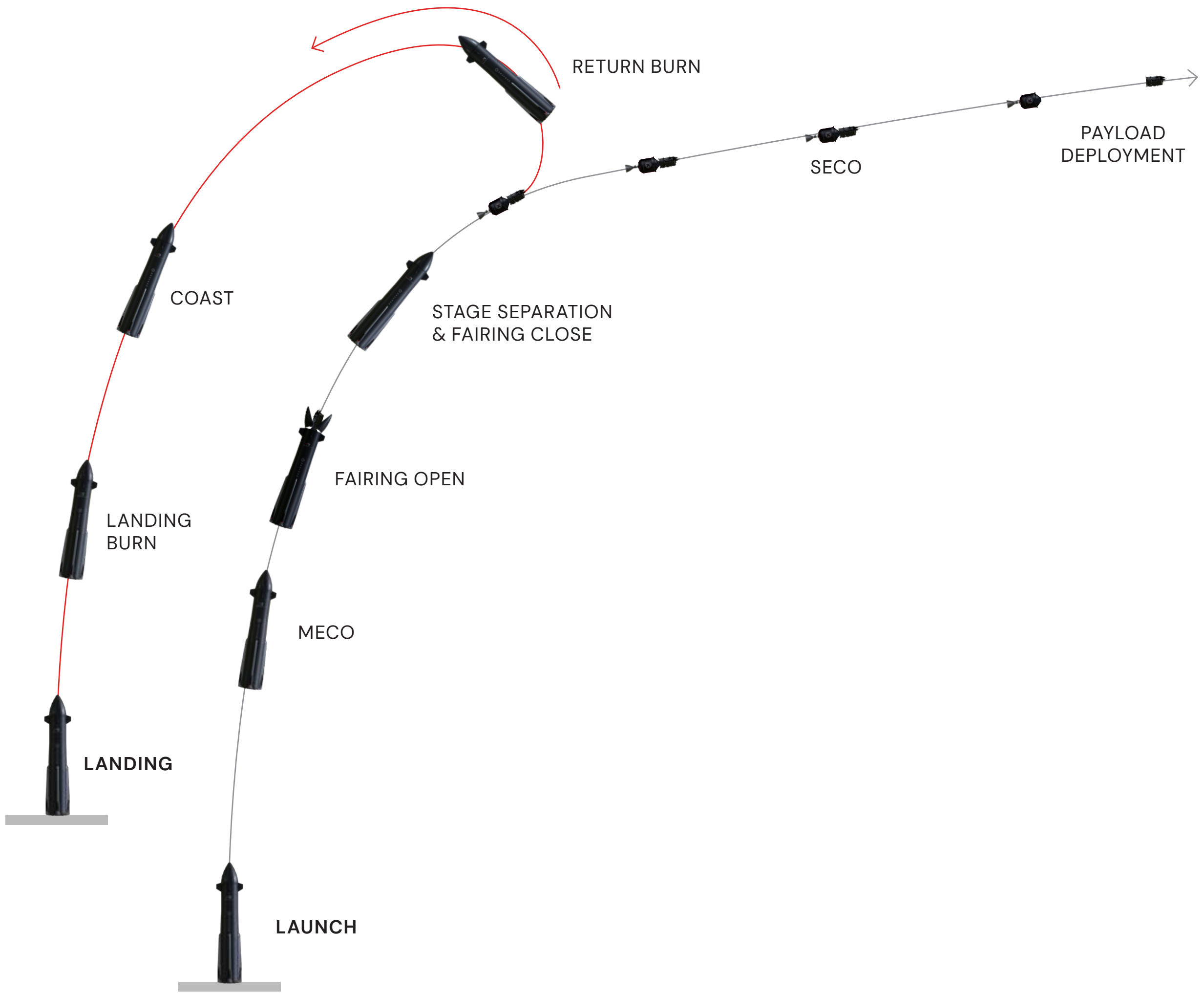


Figure 9 | Example Neutron RTLS Flight Profile

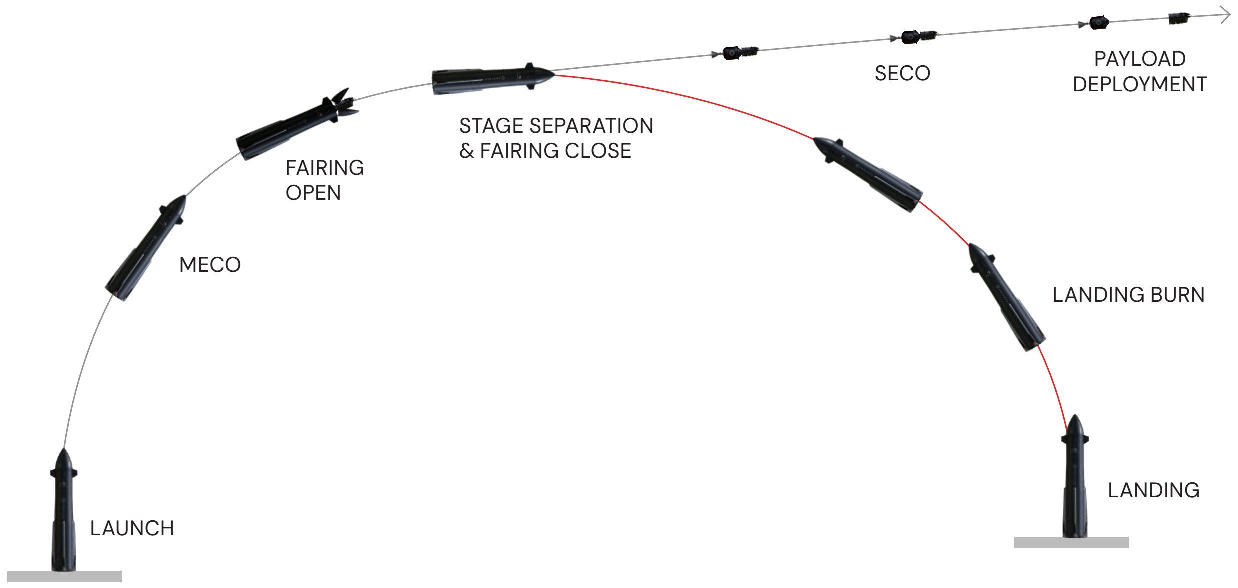


Figure 10 | Example Neutron DRL Flight Profile

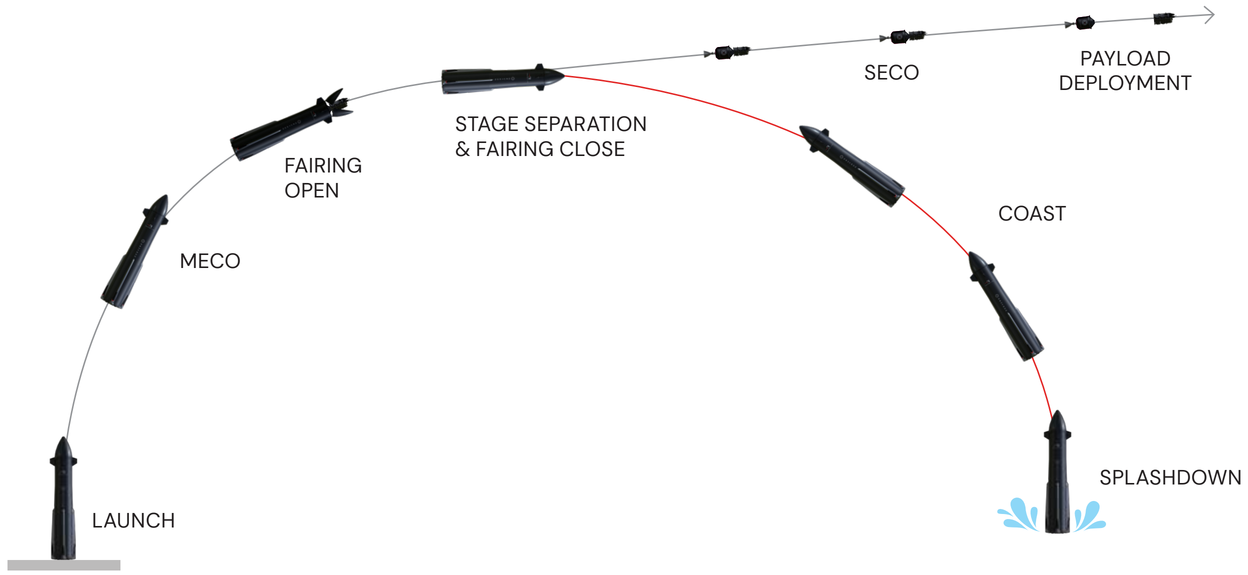
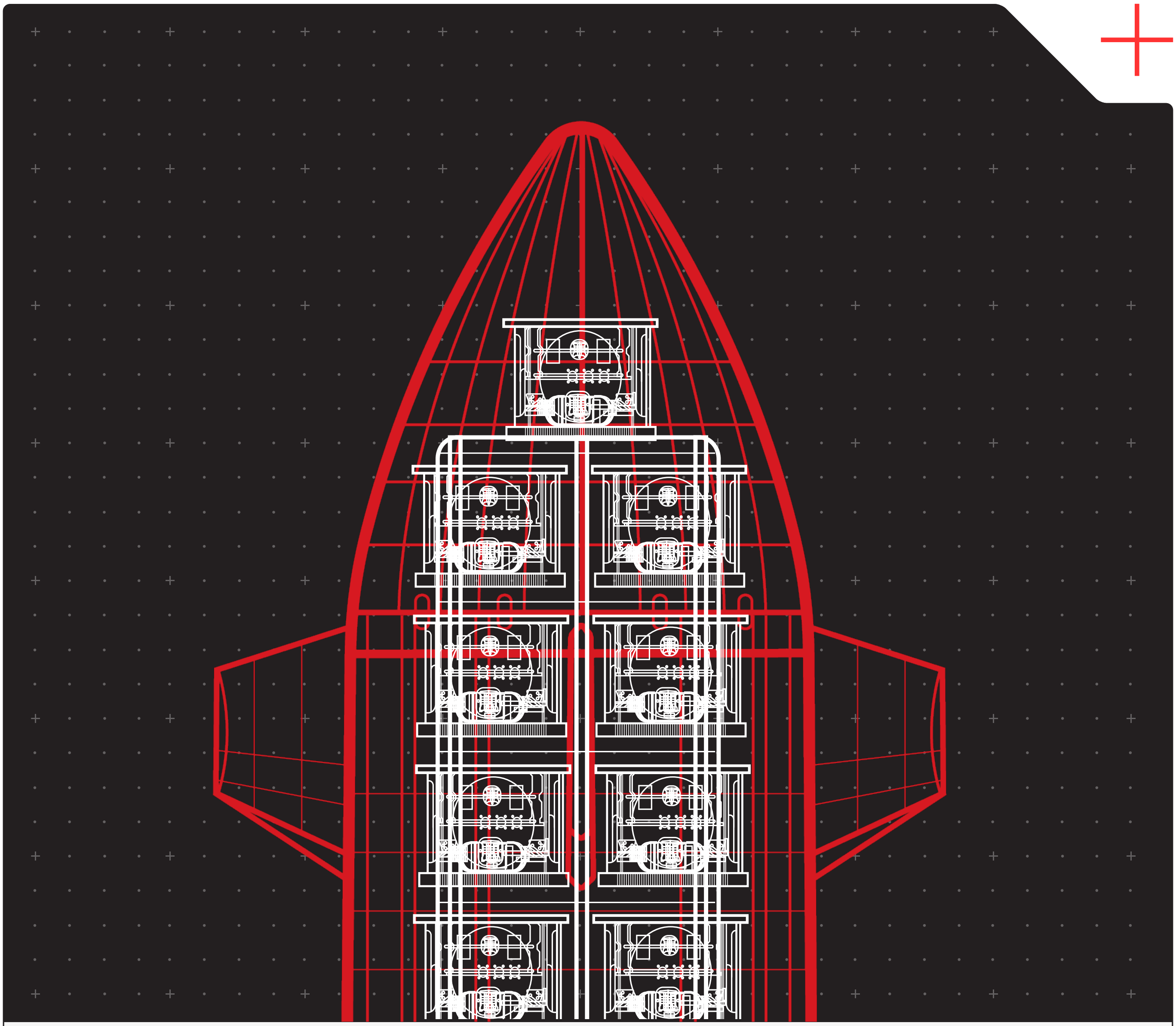


Figure 11 | Example Neutron Expendable flight profile



SECTION

4.0

PAYLOAD ACCOMMODATION

4.0

Neutron is configurable across a range of mission requirements for dedicated launches with a prime and secondary payload, as well as multiple satellites on a single launch.

Multi-manifest and rideshare missions are also possible with the restart capability of Neutron's Archimedes engine on the vehicle's Stage 2, which can deliver each payload to its own specific orbit. Neutron can also accommodate cargo and crew requirements for missions to the International Space Station (ISS).

The Neutron launch vehicle can integrate with a range of satellite separation systems and multi-payload dispensers. Rocket Lab's own payload accommodation structures are also available on request. Two access doors are available to the customer during pre-launch operations as a standard service. Additional access hatches may be available as a non-standard service and on a per-mission basis.

4.1

Payload Interface Control Document (ICD)

As a standard service, Rocket Lab provides the customer with a mission-specific Payload Interface Control Document (ICD) that defines all processes, requirements, and interfaces necessary for payload integration with a Rocket Lab launch vehicle. The ICD includes mechanical and electrical interface control drawings to aid a streamlined payload integration. Both Rocket Lab and the customer have the approving authority of the ICD, which then serves as the governing document for that particular mission. Changes to the ICD require the approval of both Rocket Lab and the customer whose mission the ICD serves.

4.2

Neutron Coordinate Frame

Neutron uses a right-hand X-Y-Z coordinate frame (Figure 12). The +Y axis is aligned with the launch vehicle's long center axis. The X & Z axes are aligned with both the strakes and the canards.

When flying horizontal, gravity is aligned with -Z. Z is the yaw axis, Y is roll axis and X is pitch.

Figure 12 | The Neutron Launch Vehicle's Coordinate Frame

4.3

Payload Accommodation

Neutron's fairing design allows for payload accommodation up to 5.5 metres in diameter (Figure 13). Expanded fairing options for non-standard payloads are possible. For more information, contact **launch@rocketlabusa.com.**

Neutron's fairing is a carbon composite split clamshell design that remains attached to the launch vehicle's Stage 1. Neutron's fairing provides environmental control during launch for the payload, which is attached to the launch vehicle's Stage 2 that is suspended inside the Stage 1. Once the payload and Stage 2 are inside the launch vehicle, Neutron's fairing remains closed through launch until the Stage 2 deployment. Upon completion of the Stage 1's ascent, Neutron's fairing opens. The Stage 2 and integrated payload is then released and Neutron's fairing is closed to enable the launch vehicle's reorientation and return to Earth. Upon completion of the Stage 2 burn, the payload then separates from its mission-unique payload adapter.

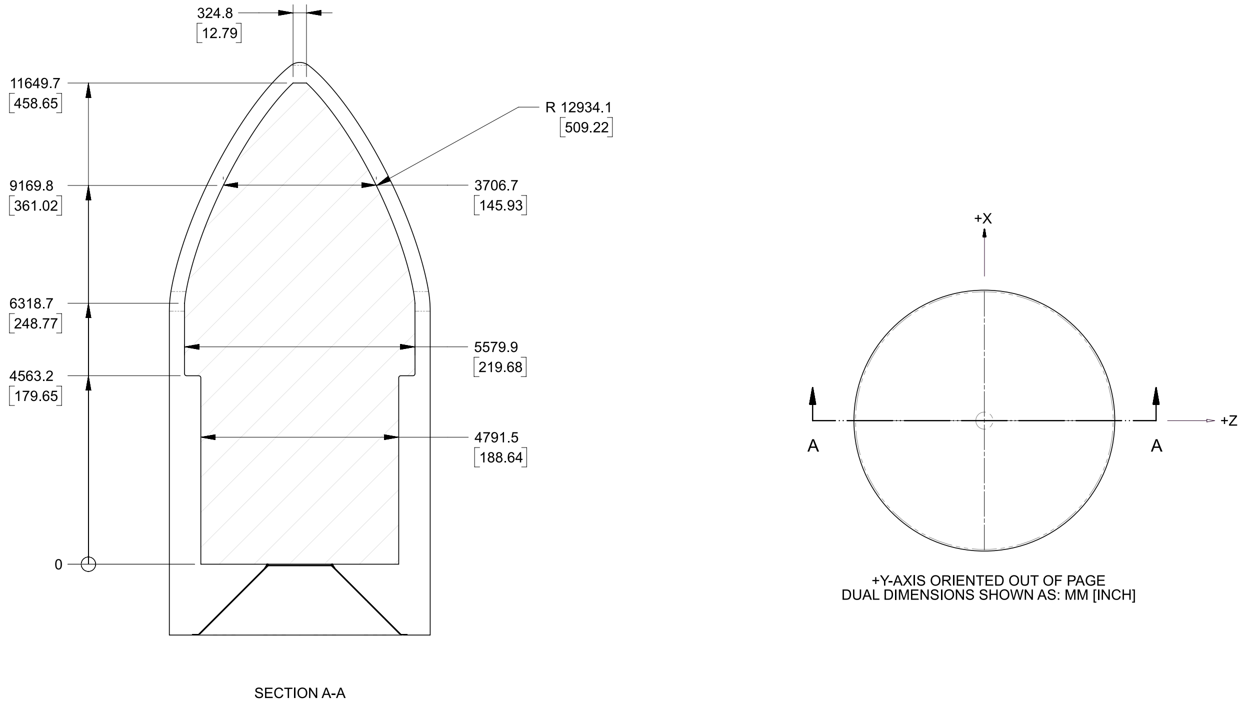


Figure 13 | Payload Accommodation Within Neutron's Fairing

4.4

Payload Support Structure

The Neutron Payload Support Structure (PSS) is a conical structure that connects the launch vehicle to the bolted payload standard interface plane. The main PSS structure is predominately graphite-epoxy composite and aluminium honeycomb sandwich panel, with machined metallic fittings and bonded surface mounts where required.

At the aft end, the PSS interfaces with the Stage 2 forward skirt through a bolted joint. The forward end terminates in a machined aluminium ring which provides the bolted standard interface plane for attaching payload adapters and dispensers, as required. The PSS includes a close-out diaphragm made of carbon-epoxy laminate on its top surface which, along with the rest of the PSS, provides a closeout for electromagnetic interference, venting, and cleanliness from the forward end of the Stage 2 and the launch vehicle's avionics and fluid systems housed therein. The PSS cone structure additionally provides a mechanical support for payload electrical harnessing up to the interface plane, and a platform for secondary payload and CubeSat dispensers.

As a standard service, Rocket Lab offers a bolt circle diameter of 1575 mm (62 in) at the standard interface plane, as detailed in Figure 14. Wider configurations, including a 2616 mm (103 in) diameter option, and customized bolt patterns are available as a non-standard service on a per-mission basis. For more information, contact **launch@rocketlabusa.com.**

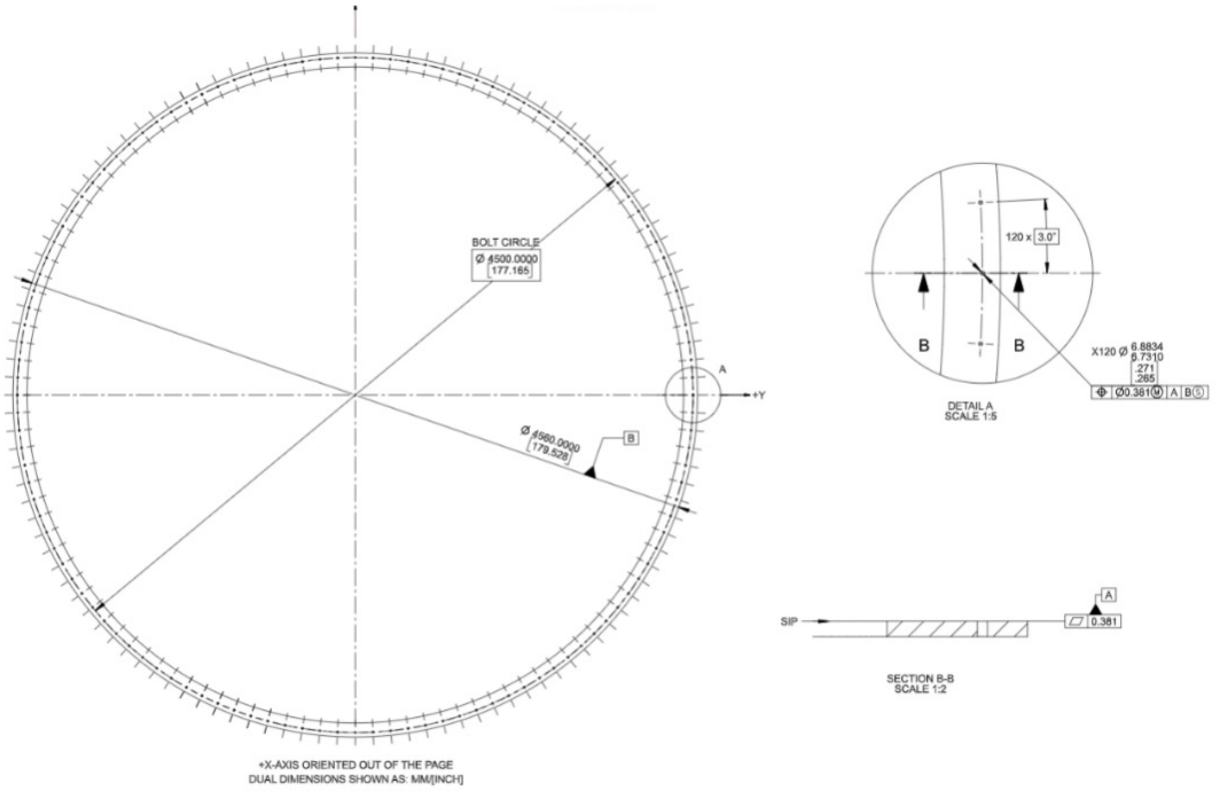


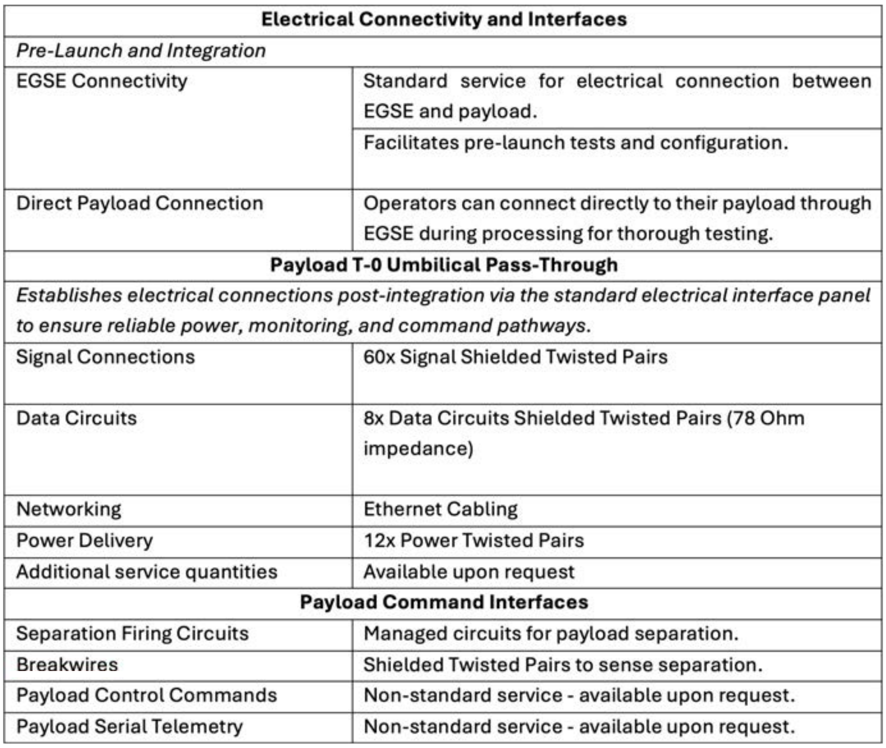
Figure 14 | Neutron Payload Attach Fitting 1575mm

4.5

Payload Electrical Interfaces

Neutron provides electrical connectivity between customer-provided electrical ground support equipment (EGSE) and the payload during pre-launch and integration activities. Satellite operators can also directly connect to their payload through their EGSE during payload processing. After integration with Neutron's Stage 2, electrical connections are made via the umbilical system through the standard electrical interface panel. This ensures power delivery, monitoring, and command capabilities. Umbilical harness specifications are defined in the mission-specific ICD, which will be provided per contractual requirements. For more information, contact **launch@rocketlabusa.com**

Table 5 | Payload Electrical Interfaces Specifications



Electrical Connectivity and Interfaces	
Pre-Launch and Integration	
EGSE Connectivity	Standard service for electrical connection between EGSE and payload. Facilitates pre-launch tests and configuration.
Direct Payload Connection	Operators can connect directly to their payload through EGSE during processing for thorough testing.
Payload T-0 Umbilical Pass-Through	
Establishes electrical connections post-integration via the standard electrical interface panel to ensure reliable power, monitoring, and command pathways.	
Signal Connections	60x Signal Shielded Twisted Pairs
Data Circuits	8x Data Circuits Shielded Twisted Pairs (78 Ohm impedance)
Networking	Ethernet Cabling
Power Delivery	12x Power Twisted Pairs
Additional service quantities	Available upon request
Payload Command Interfaces	
Separation Firing Circuits	Managed circuits for payload separation.
Breakwires	Shielded Twisted Pairs to sense separation.
Payload Control Commands	Non-standard service - available upon request.
Payload Serial Telemetry	Non-standard service - available upon request.

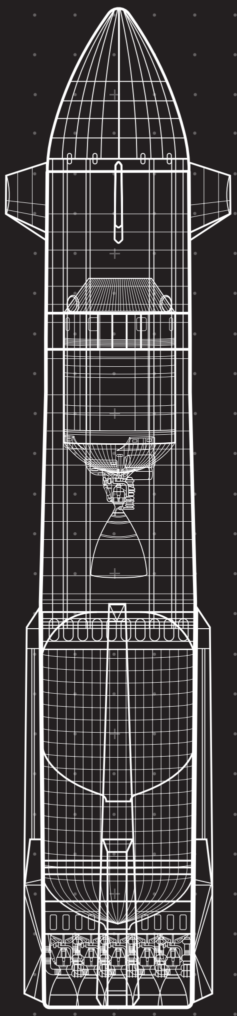
4.6

Payload Mechanical Interfaces

Neutron provides accommodation for a wide variety of payload mechanical interfaces, including standard commercial payload adapters and dispenser options, customer-provided systems, and custom solutions developed by Rocket Lab.

Primary payloads will typically use a payload adapter to connect from the bolted interface to the payload separation interface and separation system. The Neutron PSS is compatible with commercial primary payload adapters and dispensers designed to connect via the industry-standard 1575 mm or wider bolted interfaces specified in Section 4.4. Similarly, Neutron will accommodate dispensers for multi-payload stacks or rideshares, including commercially available standard options such as those based on ESPA rings, and unique mission-specific solutions.

Additionally, Rocket Lab has extensive flight-proven experience designing, manufacturing, launching, and operating bespoke and custom payload dispensers for both mission-specific primary mechanical interface needs, multi-payload accommodations, and multi-customer rideshare missions on Electron. Neutron will similarly be available with a range of Rocket Lab-developed payload adapter and multi-payload dispenser options, including standardized options with flight-proven separation system options and options for custom payload mounting. For details on both standard and custom options, contact **launch@rocketlabusa.com**.



SECTION

5.0

ENVIRONMENTS

5.0

Environmental verification involves defining lifecycle conditions for all launch vehicle units, components, sub-systems, and establishing operational flight margins. This is achieved through qualification and acceptance testing, as well as post-flight analysis.

The list of environments assessed for verification is exhaustive, and includes such commonly tested loads as random vibration, shock, thermal cycles, thermal vacuum (TVAC), static load, pressure, and electromagnetic compatibility (EMC), as well as climatic environments (humidity, salt-fog, etc). When possible, Electron design, test, and flight heritage is being leveraged to produce robust design, qualification, and acceptance of units, and sub-systems for Neutron.

The loads and environments provided in this section are for reference only. The levels presented herein are typical of max flight, limit load, or maximum predicted environment levels and do not include margin required for spacecraft or payload qualification. Final mission-specific environments will be provided to customers through the mission ICD.

5.1

Pre-Launch Environments

5.1.1

Transportation Environment

The payload will bear low frequency and magnitude acceleration loads while in transport to the Payload Processing Facility (PPF), from that facility to LC-3, and the Assembly and Integration Complex (AIC), during payload processing operations, and during the transport of Neutron and the payload to the launch pad. These transportation accelerations, along with other pre-launch loads and dynamics, are expected to be enveloped by the flight environments in all cases. Further information on the integration and transport process for pre-launch operations are provided in section 7.

5.1.2

Cleanliness, Temperature, and Humidity

The thermal and air quality environments the payload will experience at all stages of pre-launch operations and payload processing within the PPF are controlled. Standard service temperature, humidity and cleanliness environments are detailed below in Table 6. Requirements beyond the bounds of these levels can be accommodated on a case-by-case basis. Please contact **launch@rocketlabusa.com** for more information.

Table 6 | Payload Environment Cleanliness Levels

PAYLOAD TYPE	EVENT	TEMP. °C (°F)	HUMIDITY	CLEANLINESS (CLASS)
Standard	Payload Integration to Neutron	10-35 °C [50-95°F]	<50%	100,000 (Class 8)
	Payload Encapsulation to Launch*	7-35 °C [45-95°F]	<50%	10,000 (Class 7)
Sensitive Paylods	Payload Integration to Neutron	10-25 °C [50-77°F]	35-50%	100,000 (Class 8)
	Payload Encapsulation to Launch*	7-25 °C [45-77°F]		10,000 (Class 7)

*For fairing air-conditioning, Class 5,000 cleanliness can be supplied as an optional service. Inner fairing surfaces with an emissivity of 0.9, will not exceed the effective temperatures in this table.

5.1.3

Ground System Gas Delivery

Temperatures within the fairing are controlled to a range of 10-29°C (50-85°F) ± 2.8°C (5°F) using a ground-side gas system from payload integration through to launch. The maximum conditioned gas impingement velocity range on the payload envelope is 10 m/s (32 feet/second). The mission-specific maximum velocity and associated payload envelope location(s) will be defined in the mission-specific ICD.

5.2

Flight Environments

The maximum predicted flight environments the payload will experience on Neutron from launch through to payload separation on orbit are described in the following sections. Operation of the fairing, vehicle and environmental enclosures are sized to ensure a peak aerodynamic heat flux of 1135W/m2 incident upon the payload. Rocket Lab may be able to accommodate requirements outside of the environmental bounds detailed below. Please contact **launch@rocketlabusa.com** for more information.

5.2.1

Acceleration loads

Launch on Neutron will subject the payload to a range of axial and lateral accelerations, both static and dynamic. The primary static load is driven by vehicle acceleration to orbital velocity, with maximum acceleration controlled by engine throttling. Dynamic loads are caused by various environmental and operational factors, including lift-off transients, ascent winds and aerodynamic loads, main engine cutout, Stage 2 ignition and burn, and Stage 2 engine shut down. Various aspects of vehicle design and operation help enable the vehicle to fly within payload acceleration limits, including day-of-launch wind limits, trajectory optimization, and engine control.

Maximum expected equivalent quasi-static load factors for a single primary payload with mass 3,500 kg or more flying on Neutron are given in Figure 15. A second curve for payloads with mass from 1,000 kg up to 3,500 kg is also provided. These curves should be interpreted as equivalent limit-load accelerations applied to the center-of-gravity of the payload and all adapter/dispenser and separation systems above the standard interface for design sizing and verification. For multi-payload missions, the load factors can equivalently be interpreted as acting through the center-of-gravity of the combined stack of payloads and dispenser(s), though will not necessarily bound loads on all individual payloads.

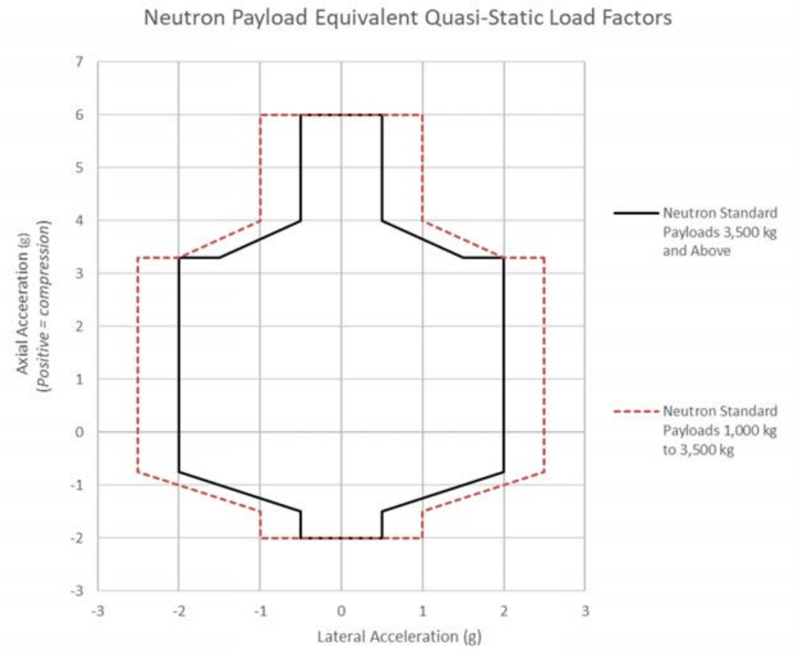


Figure 15 | Maximum Expected Equivalent Quasi-Static Load Factors

Mission-specific coupled load analysis (CLA) is available to produce detailed loads for mission-specific payload configurations and customers requiring specific accelerations outside of the environmental bounds listed below may be accommodated on request. Preliminary CLA assessments for specific payloads, standard and non-standard, as well as rideshare configurations with standard or unique dispensers are available on request. Final acceleration limits will be provided to the customer in the mission ICD. Please contact **launch@rocketlabusa.com** for more information.

Generalized sinusoidal vibration limits defined at the standard interface plane are provided in Figure 16. Mission specific sinusoidal limits defined at the payload interface will be provided in the mission ICD.

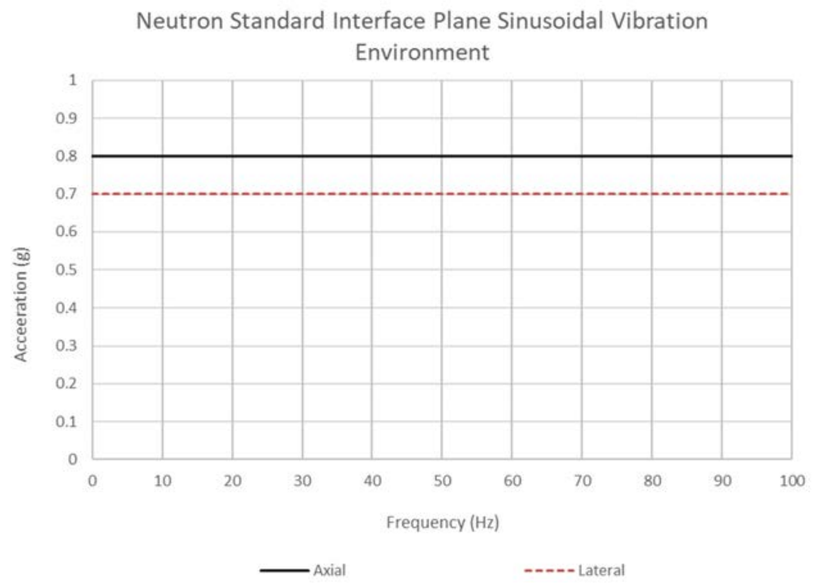


Figure 16 | Maximum Expected Sinusoidal Vibration Environment

5.2.2

Shock

Neutron will subject the payload to two shock events during flight: Stage 2 separation and payload deployment. The maximum predicted shock response at the payload interface from these shock events is shown below in Figure 17 and is also given in Table 7. Other dynamic transients, including engine starts, engine cut-offs, and fairing opening, will occur at a lower level at the payload interface and be enveloped by the provided MPE.

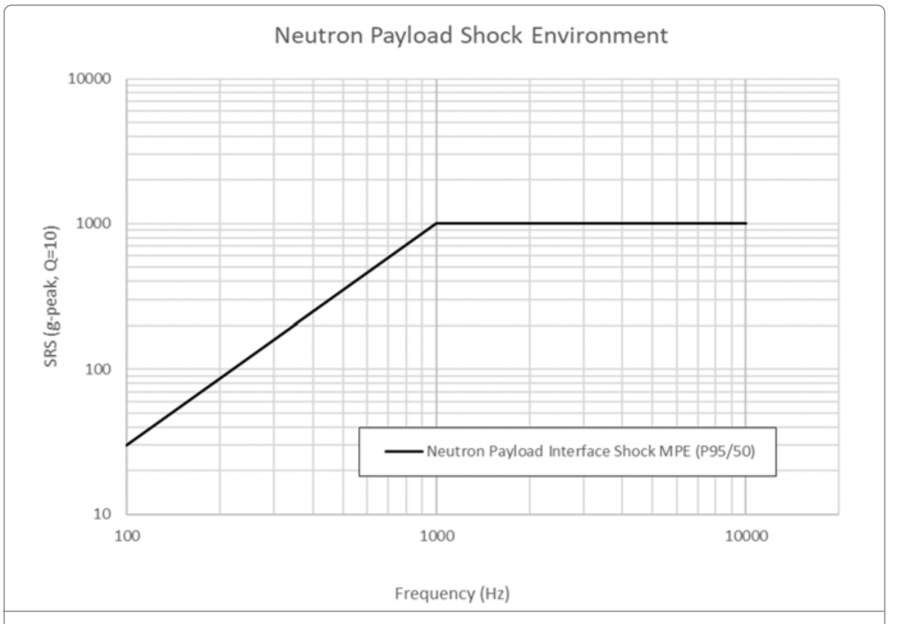


Figure 17 | Maximum Expected Shock to The Payload During Launch

Table 7 | Maximum Expected Shock to the Payload During Launch

FREQUENCY (HZ)	SHOCK RESPONSE SPECTRUM (SRS) ACCELERATION
100	30
1,000	1,000
10,000	1,000

5.2.3

Acoustics

Launch produces high acoustic levels on the payload fairing for several seconds during launch with lower levels also experienced during atmospheric ascent. The acoustic energy is attenuated by the fairing but still produces an internal acoustic environment which typically drives random vibration for all payload components. Payload acoustic tests are typically one of the primary sizing events in their lifecycles with the potential to drive substantial development and verification costs.

Neutron has several purpose-designed mitigation systems to reduce payload acoustics. The LC-3 flame duct is covered by a reinforced concrete flame duct cover (a.k.a. flame duct acoustic shroud) which provides high levels of attenuation while the launch vehicle is on the launch pad. The launch pad also includes a high-flow water system designed primarily to reduce acoustics both on the launch pad, via deluge water flow immediately aft of the engine nozzles, and via rainbirds during launch when the plume exits the flame duct. On the launch vehicle side, Neutron includes a unique and optimized high-coverage payload acoustic protection system mounted to the inner surface of the fairing.

The maximum predicted acoustic environment on Neutron for payloads up to 50% volume fill-fraction is given in Figure 18 and Table 8 for 1/3 octave bandwidth, and Figure 19 and Table 9 for full octave bandwidth. Payloads and higher volume fill-fractions relative to the Neutron payload fairing may require mission-specific analysis and additional margin. For all missions, payload-specific acoustic loads will be provided to the customer in the mission ICD.

Please contact **launch@rocketlabusa.com** for more information.

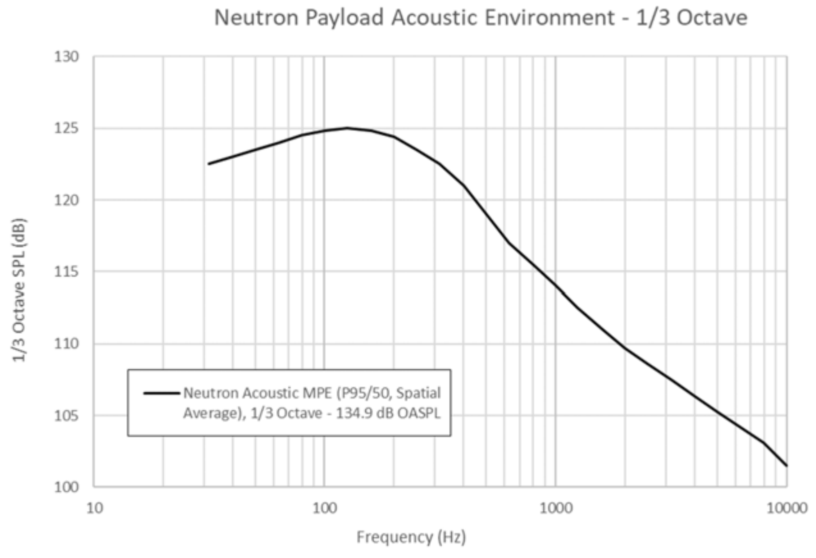


Figure 18 | Maximum Expected Acoustic Loads to the Payload During Launch (1/3 Octave Bandwidth)

Table 8 | Maximum Expected Acoustic Loads to the Payload During Launch (1/3 Octave Bandwidth)

FREQUENCY (HZ)	ACOUSTIC LIMIT LEVELS [SPL (DB, 1/3 OCTAVE)]
31.5	122.5
40	123
50	123.5
63	124
80	124.5
100	124.8
125	125
160	124.8
200	124.4
250	123.5
315	122.5
400	121
500	119
630	117
800	115.5
1000	114
1250	112.5
1600	111
2000	109.7
2500	108.6
3150	107.5
4000	106.4
5000	105.3
6300	104.2
8000	103.1
10000	101.5
OASPL (dB)	**134.9**

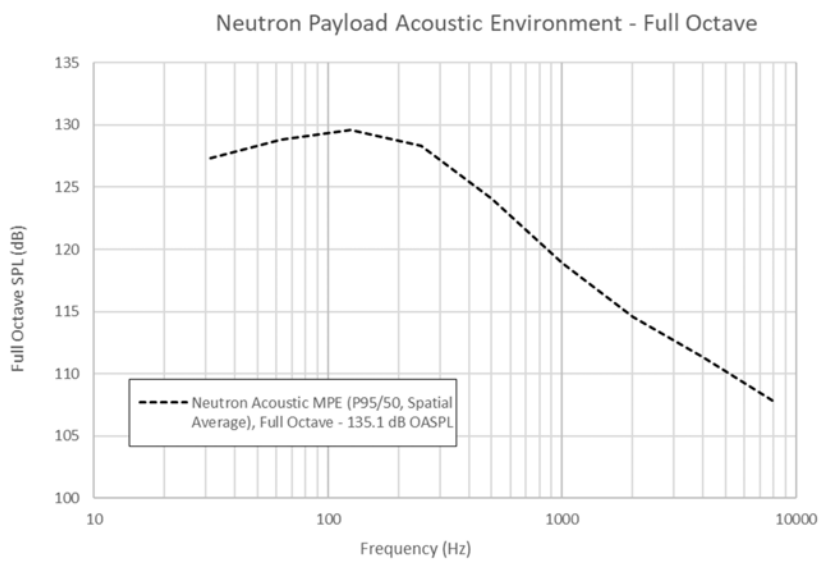


Figure 19 | Maximum Expected Acoustic Loads To The Payload During Launch (Full Octave Bandwidth)

Table 9 | Maximum Expected Acoustic Loads to the Payload During Launch (Full Octave Bandwidth)

FREQUENCY (HZ)	ACOUSTIC LIMIT LEVELS [SPL (DB, 1/3 OCTAVE)]
31.5	127.3
63	128.8
125	129.6
250	128.3
500	124.1
1000	118.9
2000	114.6
4000	111.3
8000	107.8

5.2.4

Temperature

The payload fairing is made from composite sandwich structure consisting of carbon fiber sheets with an aluminium honeycomb core. A thermal protection system is mounted to the external carbon fiber face and leads to the fairing internal surface temperatures shown in Figure 20. Fairing inner surfaces have an emissivity of not more than 0.9 and will not exceed these temperatures during ascent. The acoustic protection system mounted to most the fairing inner surface will further reduce the effective maximum temperatures visible to the payload during flight.

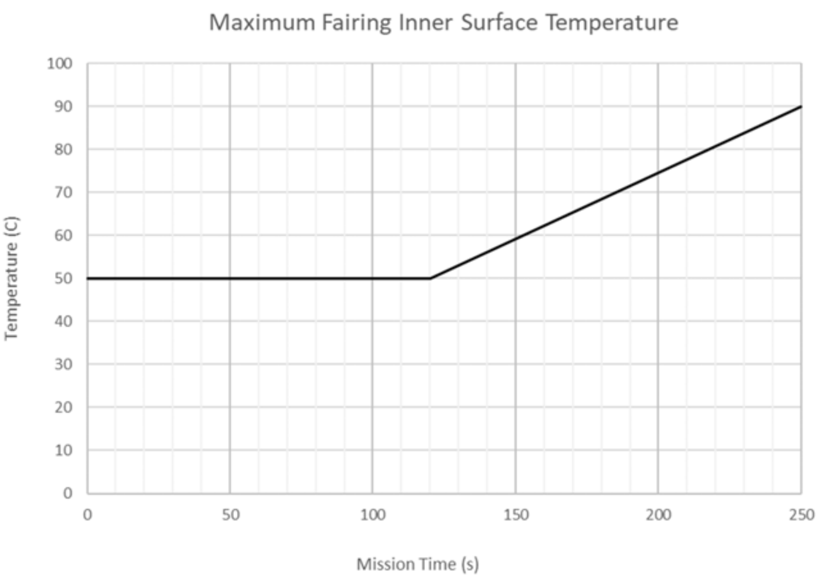


Figure 20 | Maximum Expected Payload Surface Temperatures Within Neutron's Fairing

5.2.5

EMI/EMC

Launch vehicle payloads both experience and emit electromagnetic radiation on the ground and during flight, which can interfere with the proper functioning of both payload and launch vehicle electronics systems.

The Neutron launch vehicle produces levels for electromagnetic interference (EMI) and compatibility (EMC) not higher than the levels given in Figure 21, defined notionally at the top of the standard interface plane. These levels are separate from emissions produced by the payload adapter or the payload itself and do not include additional margin for safety or qualification. The levels do contain preflight uncertainty margin which may be reduced during mission-specific analysis.

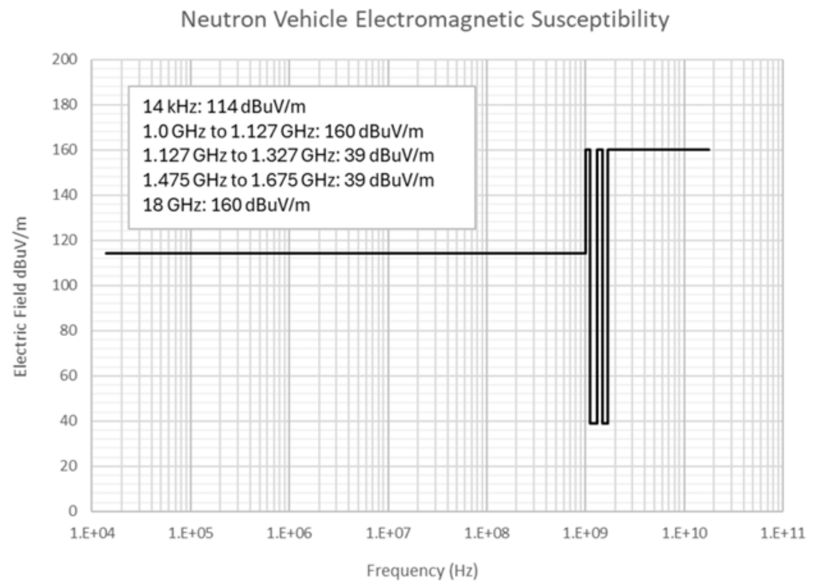


Figure 21 | Neutron Vehicle Electromagnetic Susceptibility

Maximum radiated emissions tolerable to the Neutron launch vehicle are given in Figure 22. Mission specific accommodations may likewise be possible.

Please contact **launch@rocketlabusa.com** for more information.

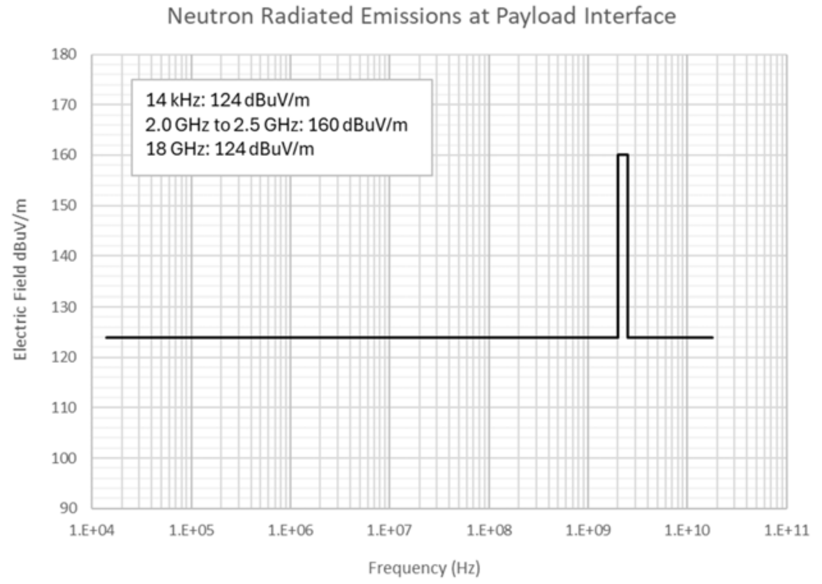


Figure 22 | Neutron Radiated Emissions At Payload Interface Environment

5.2.6
Venting

The Neutron payload fairing volume will vent to the atmosphere during ascent via a distributed venting system aft of the payload interface plane. The vent system is designed to prevent moisture ingress at any point pre or post launch while controlling the depressurization rate experienced by the payload. Venting and pressure profiles will vary with payload and trajectory. The maximum depressurization rate experienced by Neutron payloads through all phases of flight will be enveloped by the curve shown in Figure 23.

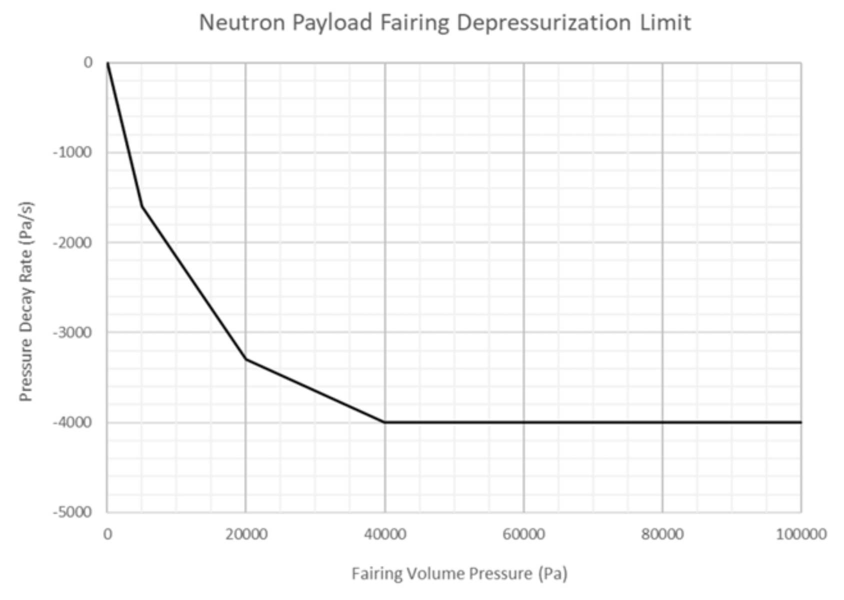
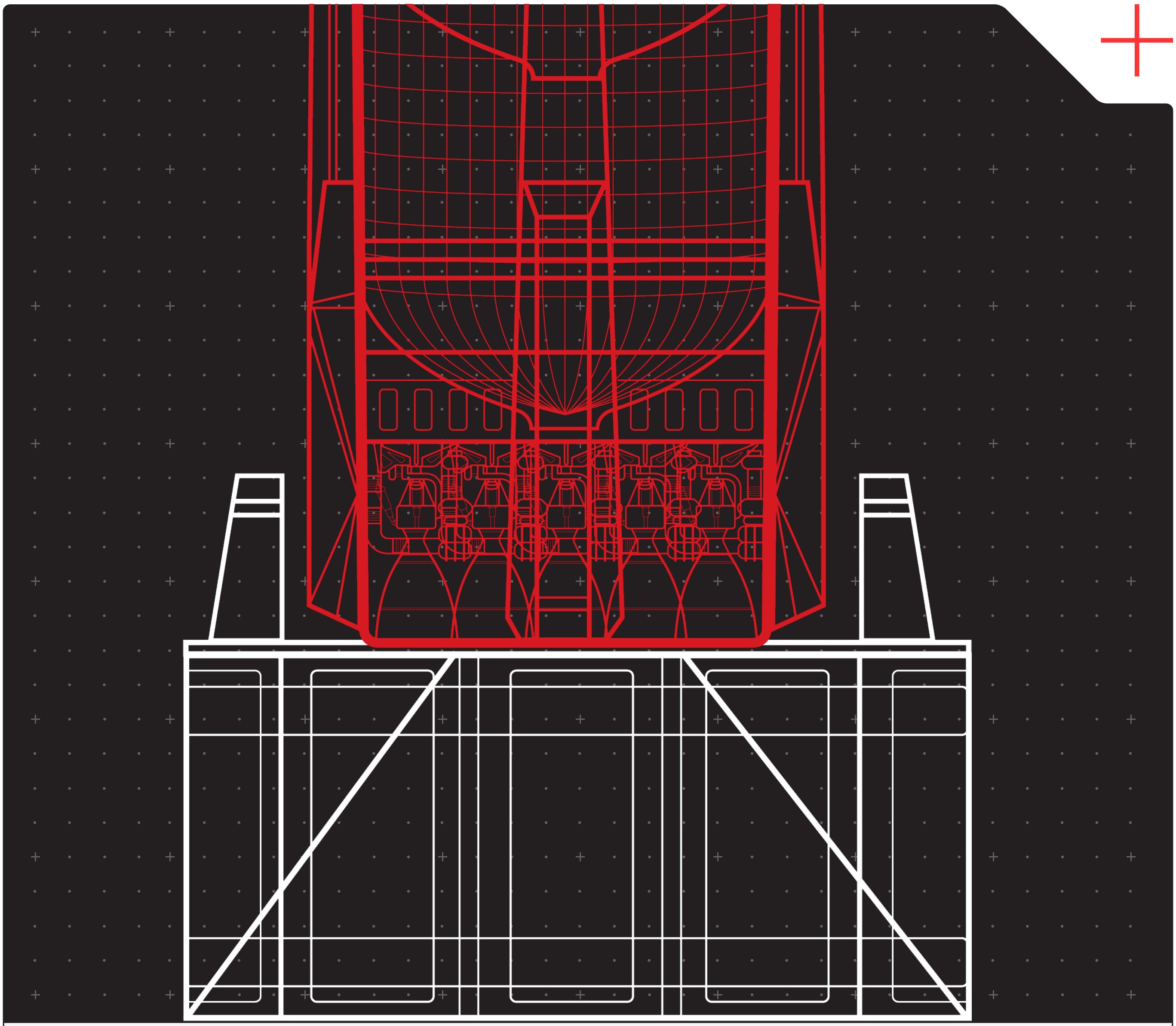


Figure 23 | Neutron Payload Fairing Depressurization Rate



SECTION

6.0

ROCKET LAB FACILITIES

6.1

Rocket Lab Launch Complex 3 – Virginia

Rocket Lab is constructing the Neutron Launch Pad and Neutron Landing Pad (collectively referred to as Launch Complex 3 or LC-3) within the NASA Wallops Flight Facility (WFF) on Wallops Island, Virginia (Figure 24). Rocket Lab has a strong partnership with the Virginia Spaceport Authority and leverages resources and infrastructure at the Mid-Atlantic Regional Spaceport (MARS). This partnership is leveraged for the rapid manufacture and initialization of launch facility development for Neutron.

LC-3 is being developed by Rocket Lab to receive and integrate Neutron launch vehicles to the Neutron Launch Pad. The site will also include extensive industrial infrastructure upgrades to support all launch, landing, and launch vehicle test operations. These include Stage 2 engine and structure stack test facilities, propellant storage and supply areas, lightning and water towers, and supporting infrastructure for the return of Neutron to the complex on a marine system used for DRL missions.

The Neutron Launch Pad is located at 37.8324 latitude, -75.4893 longitude.

Figure 24 | A Render Of Rocket Lab Launch Complex 3 In Full Operation

6.1.1

Neutron Assembly and Integration Complex - Virginia

Rocket Lab has completed the Neutron Assembly and Integration Complex (AIC) near LC-3 on a 28-acre site adjacent to NASA WFF and within 2.5 miles of LC-3 (Figure 25). AIC will encompass two buildings, Building 0 and Building 1, which will be used for final vehicle integration for Neutron and house the operations and integration team. The AIC is located directly outside the NASA WFF entrance, offering the ability of smooth transportation off public roads.

Figure 25 | All Neutron Facilities At Wallops Island Are Within Four Miles For Easy Transportation. A) LC-3, B) AIC, and C) MARS PPF.

6.1.2

Mid-Atlantic Regional Spaceport Payload Processing Facility

The Mid-Atlantic Regional Spaceport (MARS) Payload Processing Facility (PPF) provides spacecraft payload processing facilities to Rocket Lab customers launching on Neutron from LC-3. The MARS PPF (Figure 26) can concurrently support unclassified civil and commercial missions and classified national security payloads and missions.

Figure 26 | Mid-Atlantic Regional Spaceport (MARS) Payload Processing Facility (PPF).

6.1.3
Customer Facilities & Access

As a standard service, Rocket Lab provides administrative space for customers in service to the operations for their mission across LC- 3 and AIC. Located within a government-owned and controlled range, LC-3 requires controlled access. Customer pre-approval, badging, and access to LC-3 can be facilitated by Rocket Lab as required. Non-U.S. persons are subject to additional access requirements. For facilitation with access approvals, speak with your dedicated mission manager.

6.2
Space Structures Complex (SSC) - Maryland

Large-scale composite manufacturing for production vehicles occurs at the Space Structures Complex (SSC), an existing facility of over 140,000 sq ft (Figure 27). The location for SSC was chosen, in part, due to its close proximity to LC-3, and its seaport just outside of the SSC building. At this site, Rocket Lab has installed and qualified a custom-built 90-ton automatic fiber placement (AFP) machine that can move up to 98 ft (30 meters) in length and lay down continuous carbon fiber composite at a rate of 328 ft (100 meters) per minute. Production of hand lay parts that take 80 days to produce will be manufacturable in two weeks. The AFP machine also has a fully automated real-time inspection system that identifies defects throughout the laminated carbon composite and alerts the machine operator before laying down the next layer, providing additional assurance production meets design specifications.

Figure 27 | Existing Composites Production in Baltimore (SSC).

6.3
Stennis Test Complex - Mississippi

Archimedes Engine subscale and full-scale engine development, qualification and acceptance testing occurs at Rocket Lab's Stennis Test Complex (STC) within NASA's John C. Stennis Space Center in Hancock County, Mississippi (Figure 28).

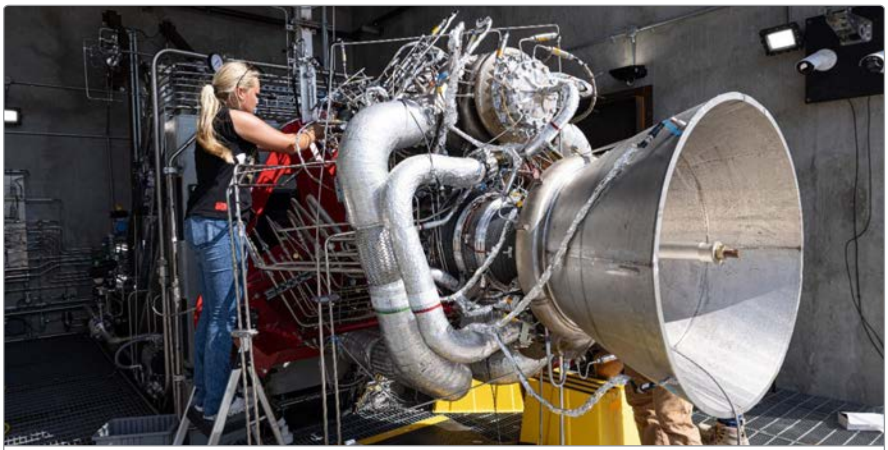


Figure 28 | The Archimedes Engine On The Test Stand At The Stennis Test Complex (STC).

6.4

Rocket Lab Headquarters - California

High-rate engine and avionics production is accomplished in the Rocket Lab Headquarters (RLHQ) and Engine Development Center (EDC) facilities, amounting to over 244,000 sq ft of production floorspace (Figure 29).

Figure 29 | Rocket Lab Headquarters (RLHQ).

6.4.1

Engine Development Complex - California

Rocket Lab's Engine Development Complex (EDC) is located in Long Beach, California (Figure 30). The site supports the development and production of the Archimedes engine for Neutron, as well as the production of Rocket Lab's Rutherford engine for its Electron launch vehicle. By co-locating its EDC near to RLHQ, Rocket Lab maximizes collaboration between its engineering and manufacturing to ensure streamlined efficiency across both Neutron and Electron.

Archimedes engines undergo checkouts, analysis, integration, and engine full assembly at EDC before being transported to STC for testing.

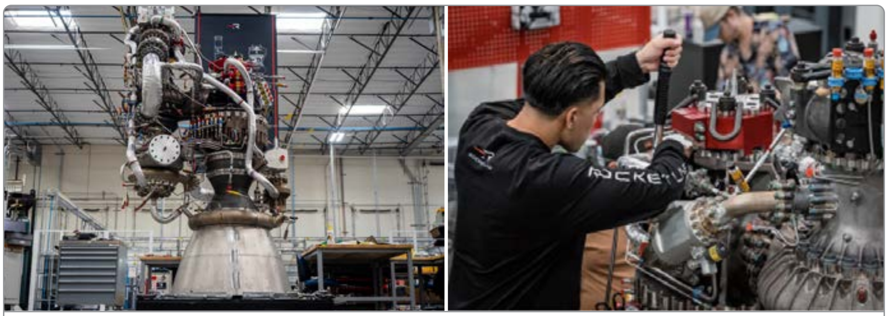
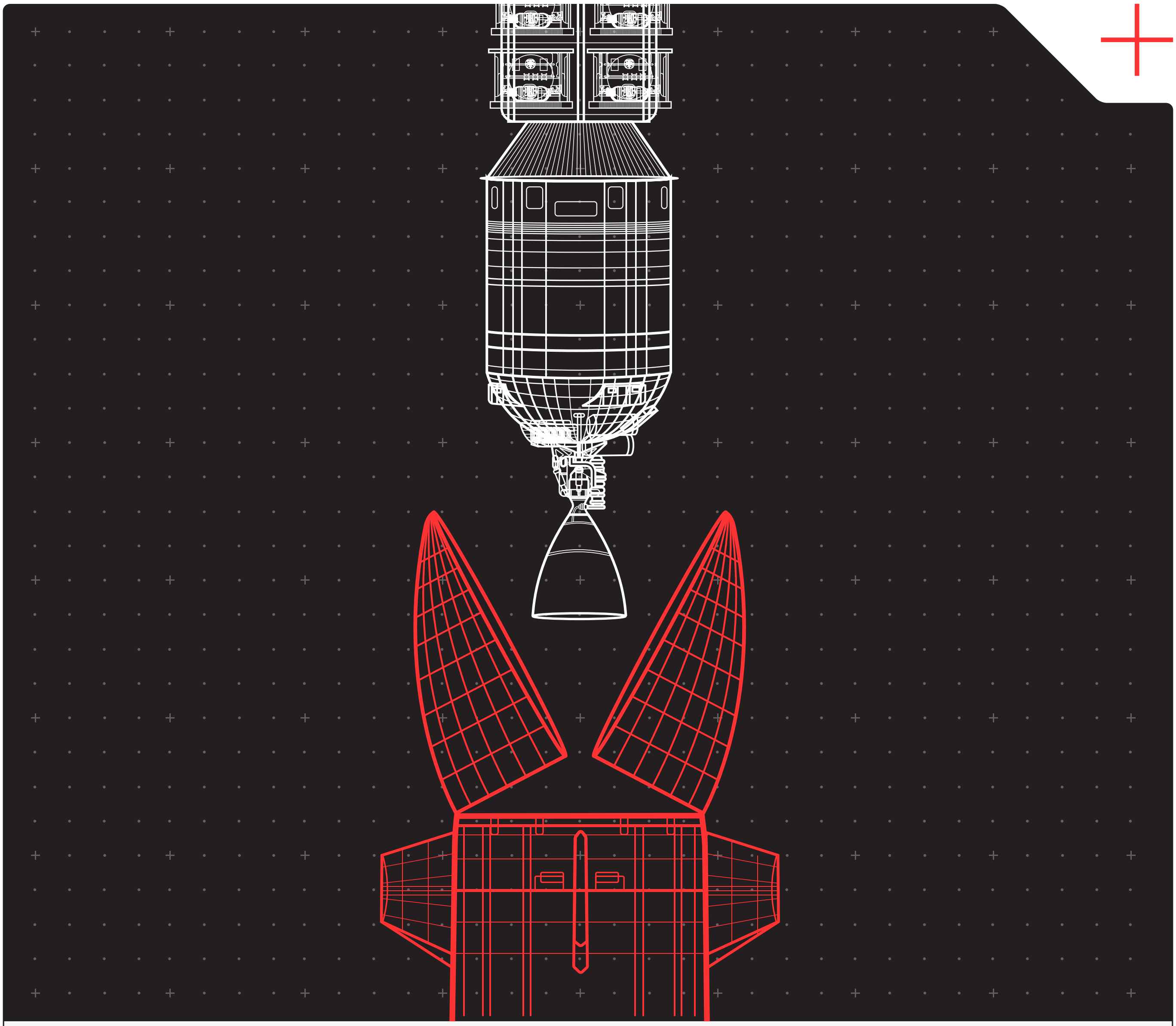


Figure 30 | The Engine Development Complex (EDC).



SECTION

7.0

LAUNCH OPERATIONS

7.0

The Neutron launch service is designed for rapid response for any mission, minimizing the time from payload integration to launch and payload deployment on orbit.

Rocket Lab's concept of operations for payload processing and launch with Neutron from LC-3 is detailed below. Rocket Lab can tailor standard payload processing and launch procedures to specific mission requirements as needed.

7.1

Pre-launch Operations

Rocket Lab has baselined a standard 24-month integration and launch schedule for Neutron in the commercial market. The activities accomplished in this time are shown in Figure 31 and are based on experience with Electron and are tailorable to meet unique mission requirements and customer readiness.

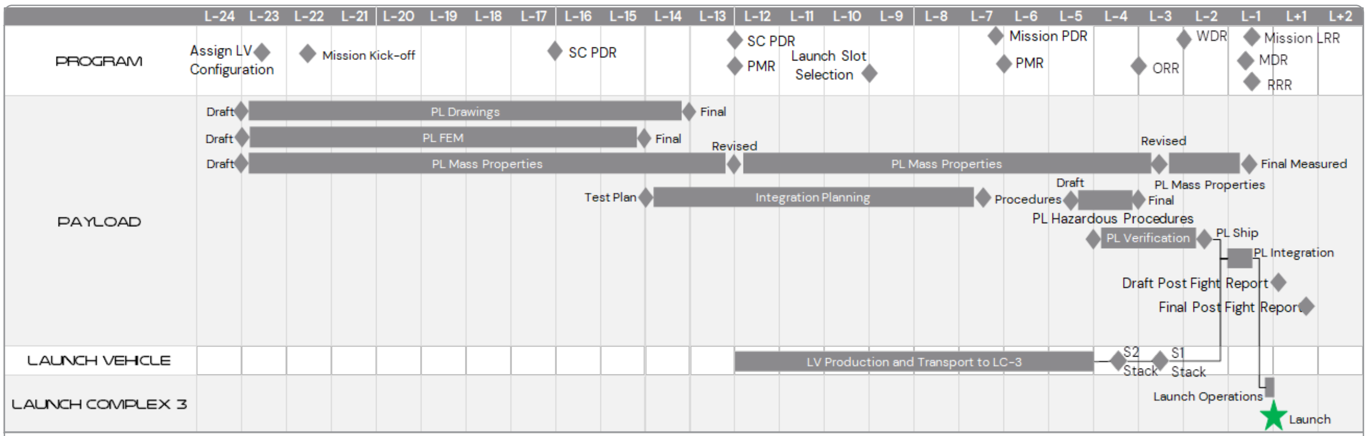


Figure 31 | Neutron L-24 Month Standard Launch Service Schedule.

The following sections detail a nominal launch and payload integration campaign for launch on Neutron. A mission-specific schedule is provided to the customer once launch contract negotiations are complete.

7.1.1

Integration Operations

Neutron design features a modular architecture that allows for the concurrent processing of the launch vehicle and the payload. The facilities used include the MARS PPF for payload processing, the AIC for mating of the Neutron second stage and its payload, and the LC-3 launch pad for final vehicle integration, WDR, and launch.

Integration operations (Figure 32) include the integration of Stage 2 into the Upper Module, the payload into the Upper Module and attachment to the Second Stage Payload Adapter, and the Upper Module onto the Core Module. Integration of Stage 2 and the payload are completed horizontally utilizing the separation system guide rails to facilitate smooth mating. Stage 2 and payload integration activities occur in cleanroom facilities to maintain payload cleanliness and environmental requirements.

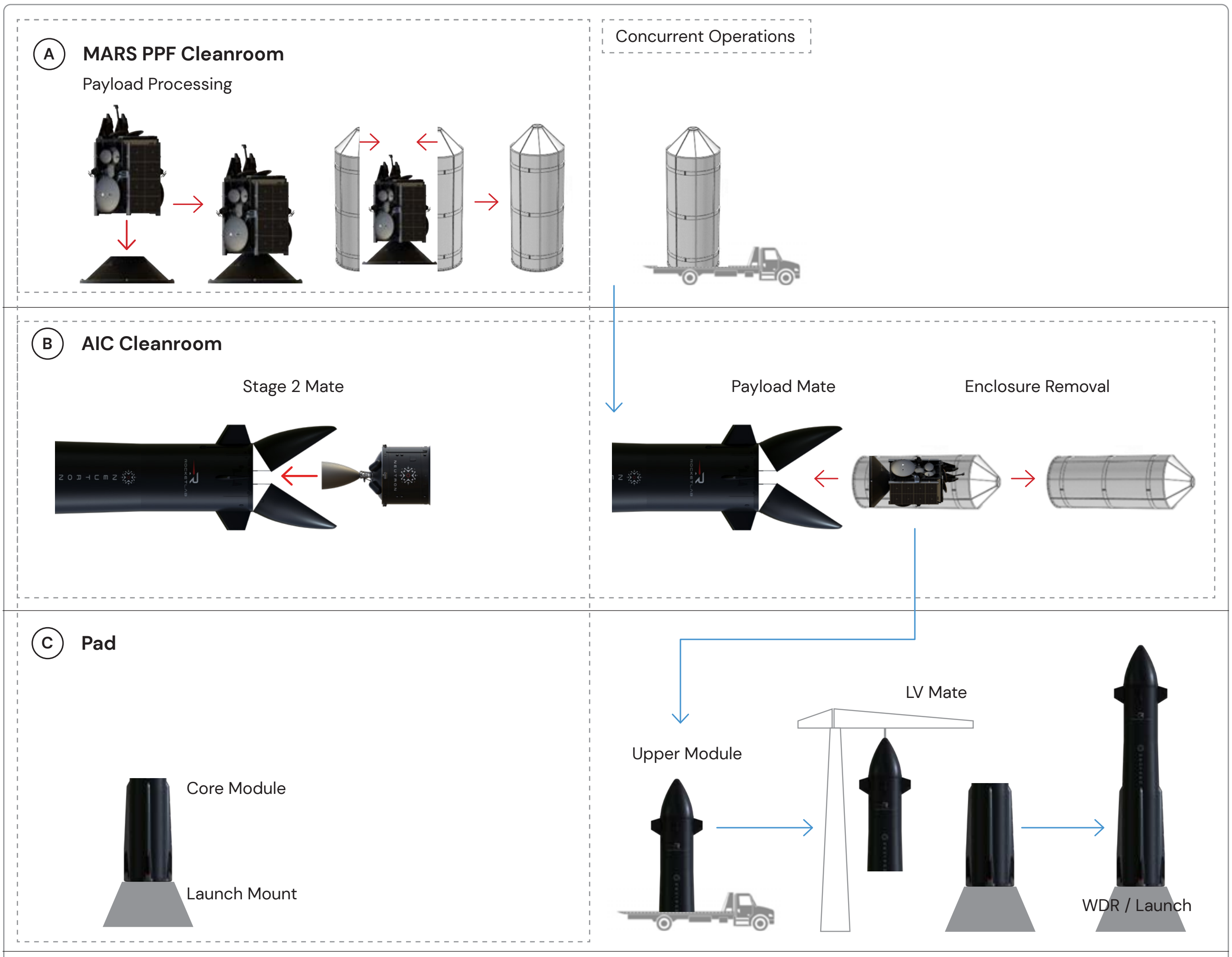


Figure 32 | Neutron Launch Site Facilities and Transport and Integration Flow.

7.1.2
Payload Processing

Rocket Lab's PPF is environmentally controlled and provides equipment, consumables, and infrastructure to support payloads being launched on Neutron. The primary location for payload processing on Wallops Island is the MARS PPF operated by the Virginia Spaceport Authority (VSA) (Figures 34 and 35). At this facility, Rocket Lab can support both non-sensitive and non-hazardous payload operations, and those which require additional infrastructure and resource to safely and securely process the payload for launch, including the loading of hypergolic propellants, and installation of ordinance. The MARS PPF can be made available to customers from three months before the scheduled launch date of their mission.

Figure 33 | Overhead View Of The MARS PPF.

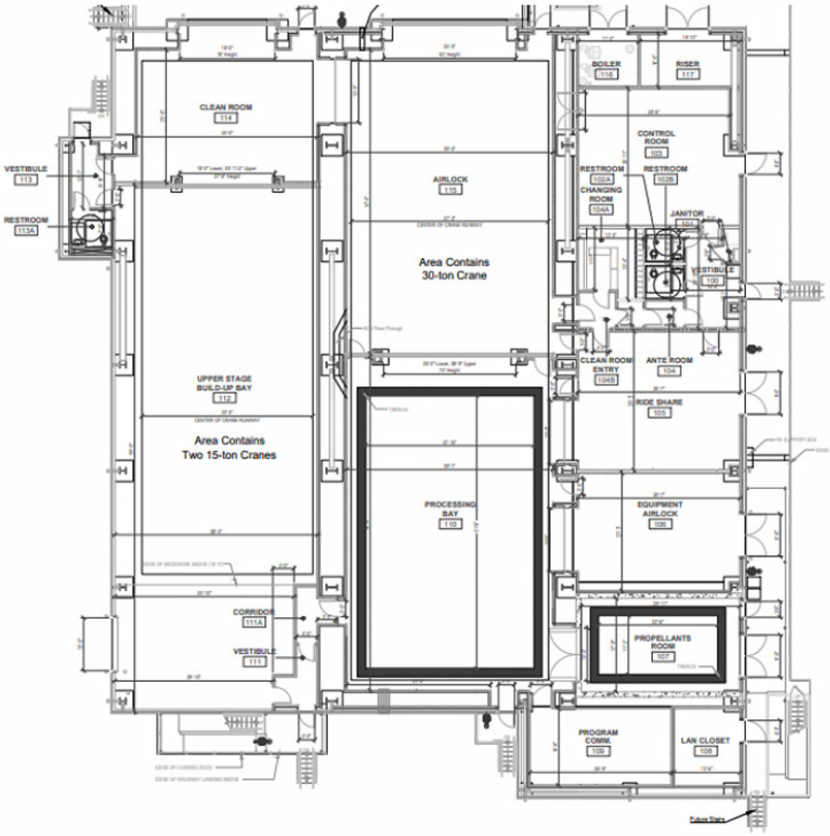


Figure 34 | Schematic Overview Of The MARS PPF

The MARS PPF includes certified ISO 8 Class 100K clean rooms, dedicated power for customer electrical ground support equipment at standard 110 VAC at 60Hz and other power as required (i.e. 208 VAC, 240 VAC, 480 VAC), compressed air and gasses including helium and nitrogen, and an overhead crane for payload integration operations. Standard payload processing services also include Rocket Lab integration support personnel, the supply of consumables including isopropyl alcohol, lint free wipes, gloves, gowns, and hair nets. Detailed security tailored to customer and mission requirements can also include electronic access control, 24-hour facility security guards, and closed-circuit video monitoring. Non-standard services are also possible, please contact **launch@rocketlabusa.com** for more information.

To begin integration, the payload is first mated to the Payload Adapter and encapsulated in a shroud (known as the Payload Transport Enclosure) at the MARS PPF. Encapsulation within this enclosure enables spacecraft cleanliness requirements (up to ISO 6.7) to be satisfied prior to flight during the transport and integration process. The flow of spacecraft encapsulation operations at the MARS PPF are detailed in Figure 36.

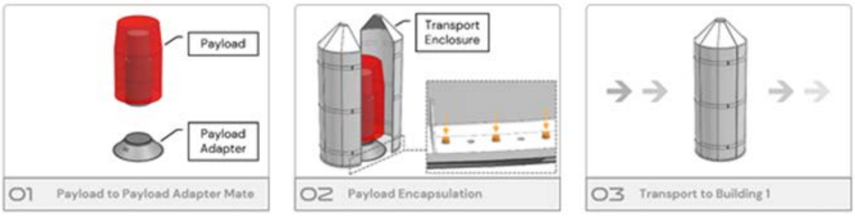


Figure 35 | Spacecraft Encapsulation Process.

Following encapsulation, the payload is transported to AIC Building 1 for integration with the Stage 1 Upper Module (Figure 37). The Transport Enclosure provides an ISO 8 (Class 100,000) clean environment and protects the payload from damage prior to integration with the launch vehicle.

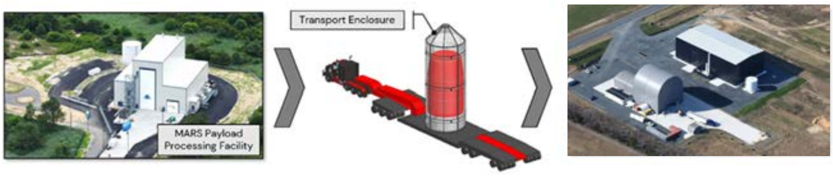


Figure 36 | Encapsulated Spacecraft Transport to AIC Building 1.

7.1.3
Transportation

Neutron transportation utilizes a simple and modular transportation method that allows the concurrent transportation of the launch vehicle and the payload. During launch operations, the launch vehicle and all launch vehicle assets are transported between facilities using the Neutron transporter assembly. This trailer configuration is a double-wide, four front axle and six rear axle platform trailer using one modular transporter at the front and another modular transporter at the rear. ISO 8 cleanroom standards are met during all payload processing and transportation activities. Stage 1 assembly is completed using a crane at the launch pad. The processing and transportation of the payload, Stage 1, and the Stage 1 Core Module are all completed concurrently which enables a flexible approach to manifest management and efficient launch processing operations.

7.2

Launch Operations

The following table (Table 10) provides a description of the launch operations and activities that will occur for a Neutron launch.

Table 10 | Neutron Day of Launch Operations, Activity Descriptions

OPERATION	DESCRIPTION OF ACTIVITY
From L-1 Operations	After operations from L-1 are complete, the launch vehicle is stored vertically on the launch pad where it is fully integrated with the payload. During this period the payload is environmentally conditioned by the ground-side HVAC system using either a conditioned air or nitrogen supply. The space vehicle interface panel remains connected to the payload and is accessible by the customer throughout this period.
Ground System Bootup and Checkouts	Launch day begins by performing the initialization and setup of ground-side systems to activate LC-3. For fluidic, electrical, and control systems this includes: • inspections to verify measured and actual states • recording initial sensor readings; and • actuating components to verify expected response.
Launch Vehicle Bootup and Checkouts	After LC-3 setup is complete, the launch vehicle is powered on while hazardous functions are inhibited by ground-side interlock control lines. Post-boot-up performance verification of hazardous and non-hazardous systems is performed to ensure that all systems are operating nominally, the former requiring localized evacuations of personnel. During this period, LC-3 fluidic systems are chilled-in and prepared to deliver commodities to the launch vehicle.
Inert Gas and Propellant Fill Operations	After post-boot checks are complete, personnel are evacuated from the site and inert gas systems (GN2 and GHe) and propellants (LOx and LNG) are filled to 100% within one hour. After fill operations are complete, propellant top-up operations are performed to condition the stored propellant until the auto sequence begins.
Status Poll for Launch	After inert gas and propellant fill operations are complete, propellant top-up operations begin and operators perform a status poll for launch to verify that all systems are operating nominally. If an issue has arisen, this provides an opportunity to hold the launch countdown. After the "Go/No-Go" poll, any final checks are performed prior to the launch vehicle taking control of the range. During this period, the launch pad hold down system and the Autonomous Flight Safety System (AFSS) are armed.
Auto sequence	With two (2) minutes remaining in the launch countdown, control over the range is transferred to the launch vehicle and the auto sequence begins. The launch vehicle is transferred to internal battery power, and propellant fill and drain valves are closed allowing Stage 1 and Stage 2 propellant tanks to be pressurized. At T-15 seconds the deluge system is activated, before engine ignition occurs and performance is verified independently by the launch vehicle. If performance is nominal, the launch pad Stage 0-Stage 1 umbilical retracts, followed by the hold down system releasing the launch vehicle at T+4 seconds.
Launch Site Recycle	After the launch vehicle leaves the launch pad, the site automatically begins to perform safing activities, inspections, and is recycled for a subsequent launch campaign.

7.2.1

Recycle and scrub

Neutron is designed to be able to recycle multiple times during a launch window where necessary and viable. In the event of a scrub, the environmental controls will monitor and maintain required temperatures supporting the payload requirements. The launch pad systems and Neutron vehicle design can also support a 24-hour turnaround for enabling the rapid and responsive launch opportunities where necessary.

7.3

Post launch reporting

Post launch reporting is provided to the customer as a standard launch service with Neutron. These reports will include data to confirm a successful payload separation has occurred, including the separation state vector from payload deployment and estimated payload injection information including orbital parameters and epoch. Further reporting is possible as a non-standard service.

7.4

Launch Operational Safety

Safety is paramount in working around payloads and launch vehicles. Rocket Lab strictly follows all safety requirements and guidelines for all operations. All Rocket Lab procedures and operations will be reviewed and approved by internal safety. All hazardous operations occurring in MARS PPF will be reviewed and approved by VSA and when required NASA WFF Safety Office. Procedures for hazardous payload operations occurring at the launch pad may require review and approval by Rocket Lab and applicable range safety prior to execution.

8.0

Document References

8.1

List of Figures

Figure 1: Neutron Launch Vehicle	6
Figure 2: Neutron First Stage With Captive Fairing	9
Figure 3: Neutron Stage 2 + Payload	10
Figure 4: Archimedes Engines In Production At Rocket Lab's Engine Development Complex	11
Figure 5: Render Of A Neutron Down Range Landing (DRL) Maneuever	13
Figure 6: Neutron Expendable (EXP) Performance	17
Figure 7: Neutron Down Range Landing (DRL) Performance	17
Figure 8: Neutron Return-To-Launch-Site (RTLS) Performance	18
Figure 9: Example Neutron RTLS Flight Profile	19
Figure 10: Example Neutron DRL Flight Profile	20
Figure 11: Example Neutron Expendable flight profile	20
Figure 12: The Neutron Launch Vehicle's Coordinate Frame	22
Figure 13: Payload Accommodation Within Neutron's Fairing	23
Figure 14: Neutron Payload Attach Fitting 1575mm	24
Figure 15: Maximum Expected Equivalent Quasi-Static Load Factors	28
Figure 16: Maximum Expected Sinusoidal Vibration Environment	29
Figure 17: Maximum Expected Shock to The Payload During Launch	30
Figure 18: Maximum Expected Acoustic Loads to the Payload During Launch (1/3 Octave Bandwidth)	31
Figure 19: Maximum Expected Acoustic Loads To The Payload During Launch (Full Octave Bandwidth)	32
Figure 20: Maximum Expected Payload Surface Temperatures Within Neutron's Fairing	33
Figure 21: Neutron Vehicle Electromagnetic Susceptibility	34
Figure 22: Neutron Radiated Emissions At Payload Interface Environment	34
Figure 23: Neutron Payload Fairing Depressurization Rate	35
Figure 24: A Render Of Rocket Lab Launch Complex 3 In Full Operation	37
Figure 25: All Neutron Facilities At Wallops Island Are Within Four Miles For Easy Transportation. A) LC-3, B) AIC, and C) MARS PPF.	38
Figure 26: Mid-Atlantic Regional Spaceport (MARS) Payload Processing Facility (PPF).	38
Figure 27: Existing Composites Production in Baltimore (SSC).	39
Figure 28: The Archimedes Engine On The Test Stand At The Stennis Test Complex (STC).	39
Figure 29: Rocket Lab Headquarters (RLHQ).	40
Figure 30: The Engine Development Complex (EDC).	40
Figure 31: Neutron L-24 Month Standard Launch Service Schedule.	42
Figure 32: Neutron Launch Site Facilities and Transport and Integration Flow.	43
Figure 33: Overhead View Of The MARS PPF.	47
Figure 34: Schematic Overview Of The MARS PPF	47
Figure 35: Spacecraft Encapsulation Process.	48
Figure 36: Encapsulated Spacecraft Transport to AIC Building 1.	48

8.2

List of Tables

Table 1: Neutron Launch vehicle Characteristics 12
Table 2: Neutron Mass To Orbit Capability 17
Table 3: Neutron Orbital Injection Accuracy Performance 18
Table 4: Neutron Separation Attitude Accuracy Performance 18
Table 5: Payload Electrical Interfaces Specifications 25
Table 6: Payload Environment Cleanliness Levels 27
Table 7: Maximum Expected Shock to the Payload During Launch 30
Table 8: Maximum Expected Acoustic Loads to the Payload During Launch (1/3 Octave Bandwidth) 32
Table 9: Maximum Expected Acoustic Loads to the Payload During Launch (Full Octave Bandwidth) 33
Table 10: Neutron Day of Launch operations, Activity Descriptions 46

8.3

List Of Acronyms

3D	Three dimensional
AFP	Automatic Fiber Placement
AFSS	Autonomous Flight Safety System
AIC	Assembly and Integration Complex
CLA	Coupled Load Analysis
deg/sec	degrees per second
DRL	Down Range Landing
EDC	Engine Development Complex
EGSE	Electrical Ground Support Equipment
EMC	Electromagnetic Compatability
EMI	Electromagnetic Interference
ESPA	EELV Secondary Payload Adapter
EXP	Expendable
FAA	Federal Aviation Administration
GHe	Gaseous Helium
GN2	Gaseous Nitrogen
GTO	Geostationary Transfer Orbit
HITL	Hardware-In-The-Loop
HVAC	heating, ventilation, and air conditioning
HZ	Frequency
I/O	Input/Output
ICD	Interface Control Document
in	Inches
ISS	International Space Station
km	Kilometers
kN	Kilo Newtons
lbf	Pounds of Thrust
lbm	Pound-mass
LC-3	Launch Complex 3
LNG	Liquefied Natural Gas
LOx	Liquid Oxygen
m/s	Meters Per Second
MARS	Mid-Atlantic Regional Spaceport
MARS PPF	Mid-Atlantic Regional Spaceport's Payload Processing Facility
mm	Millimeters
MSS	Mounting Support Structure
MTO	Mass To Orbit
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
nmi	Nautical Mile
NSSL	National Security Space Launch
OASPL	Overall Sound Pressure Level
Ohm	Unit of electrical resistance
ORSC	Oxidizer Rich Staged Combustion
PPF	Payload Processing Facility
PSS	Payload Support Structure
RF	Radio Frequency
RKLB	Rocket Lab's Nasdaq ticker
RLHQ	Rocket Lab Headquarters
RP-1	Rocket Propellant
RTLS	Return To Launch Site
sq ft	square foot/feet
SRS	Shock Response Spectrum
SSC	Space Structures Complex
SSO	Sun Synchronous Orbit
STC	Stennis Test Complex
T-0	Time Equals Zero
TPS	Thermal Protection System
TVAC	Thermal Vacuum
U.S.	United States
VSA	Virginia Spaceport Authority
WDR	Wet Dress Rehearsal

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