



BLUE ORIGIN

NEW GLENN

BLUE ORIGIN



NEW GLENN
PAYLOAD
USER'S GUIDE

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HOW TO USE THIS GUIDE

This Payload User's Guide (PUG) provides an overview of the New Glenn launch system's capabilities and Blue Origin's service offering. The PUG describes New Glenn's performance, environments, requirements, interfaces, facilities, and operations. Blue Origin's customer integration team will work closely with customers and the spacecraft manufacturers to ensure successful flights aboard New Glenn.

CONTACT INFORMATION

As Blue Origin works step by step toward the goal of New Glenn's first launch, we are eager to engage with you, our customer. For technical inquiries or for more information on New Glenn plans, pricing, and availability, customers should contact the *Sales, Marketing & Customer Experience* team via email at [NewGlenn@blueorigin.com](mailto>NewGlenn@blueorigin.com).

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PREFACE

At Blue Origin, our mission is to develop reliable low-cost launch vehicles and customer-focused services that will enable a thriving commercial orbital ecosystem. The goal is to foster new industries that can access the limitless resources of space and improve life here on Earth. We envision a future where millions of people will be living and working in space.

Since our founding by Jeff Bezos, Amazon Founder and CEO, Blue Origin has been working on reusable propulsion technologies and space transportation systems necessary to make commercial spaceflight safe, affordable, and routine. We believe low-cost space access will dramatically reduce barriers to entry for new commercial and governmental activities in space.

Continuous improvements in design, testing, and manufacturing capabilities, as well as a rigorous systems engineering process are at the core of our philosophy. This incremental approach embodied in our motto, *Gradatim Ferociter* (Latin for “step by step, ferociously”), led to the historic flight and successful reuse of our New Shepard suborbital vehicle program in 2015. New Shepard demonstrated key enabling capabilities, such as vertical takeoff and landing, deeply throttleable cryogenic engines, rapid inspection, and operational reuse. These fundamental technology building blocks lead directly to our next step, the New Glenn orbital launch system.

The New Glenn launch system is designed to launch spacecraft into low Earth orbit (LEO), geostationary transfer orbit (GTO), and beyond. New Glenn is designed from the ground up to deliver reliable and affordable services:

Real, operational reusability of New Glenn’s first stage booster minimizes expense and time required for refurbishment between flights. Because no disassembly or subsystem replacements are necessary, the cycle time of New Glenn between flights is measured in days and hours, rather than months. The booster engines use clean and economical liquefied natural gas. We integrate our rocket horizontally and then roll out to the pad and launch within hours. This commercial approach results in a higher mission frequency and lower operational cost.

Advanced, efficient manufacturing techniques drive down the cost of building New Glenn. We use state-of-the-art additive manufacturing to speed development, using materials and processes developed for maintainability. The first and second stage engines share common heritage technology, and our first and second stage propellant tanks share common tooling. We design, manufacture, assemble, and test our own fairings and stages, including tanks, fluid systems, avionics, and engines.

Robust schedule reliability and system safety generate fewer launch delays and therefore meaningful cost-savings. We plan to operate multiple missions in parallel and can surge on demand to meet deadlines, while autonomous operations streamline costs and improve safety. New Glenn's unique aerodynamic features, high availability during inclement weather, and high-capacity/redundant ground systems improve accessibility of launch windows. We understand our system well and require system-wide fault tolerance, as well as conservative factors of safety. You can rely on New Glenn to operate as designed.

With New Glenn, we seek to help our customers achieve their spaceflight objectives, as your success is our primary focus. Your feedback will make New Glenn more capable and customer-friendly, and together we will make the benefits of space accessible for everyone.

Gradatim Ferociter!

The Blue Origin Team

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1.0 INTRODUCTION

1.0 INTRODUCTION



1.1 NEW GLENN LAUNCH SYSTEM DESCRIPTION

The New Glenn architecture is a high-performance space launch system designed to meet requirements for fault tolerance, safety, and reusability – all consistent with providing a reliable space transportation capability.

Blue Origin has designed New Glenn from the beginning as a robust system to launch customers to low Earth orbit (LEO), geostationary transfer orbit (GTO), cislunar space, and beyond.

New Glenn (Figure 1-1) offers a single two-stage vehicle configuration for all initial customer missions, enhancing reliability and lowering cost. The first stage booster is designed for full reusability, and is recovered downrange on a sea-going landing platform. The second stage is expendable. A three-stage configuration is planned for future missions, but is not addressed in this PUG.

The payload fairing (PLF) sits atop the launch system, protects the customer's payload, and provides benign spacecraft environments

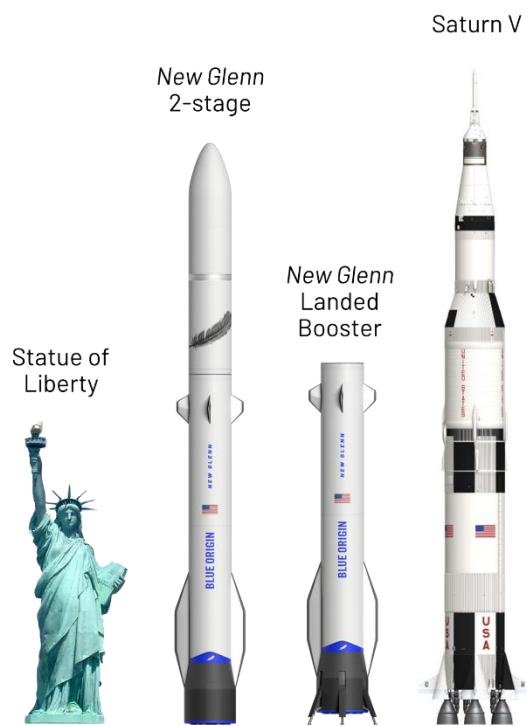
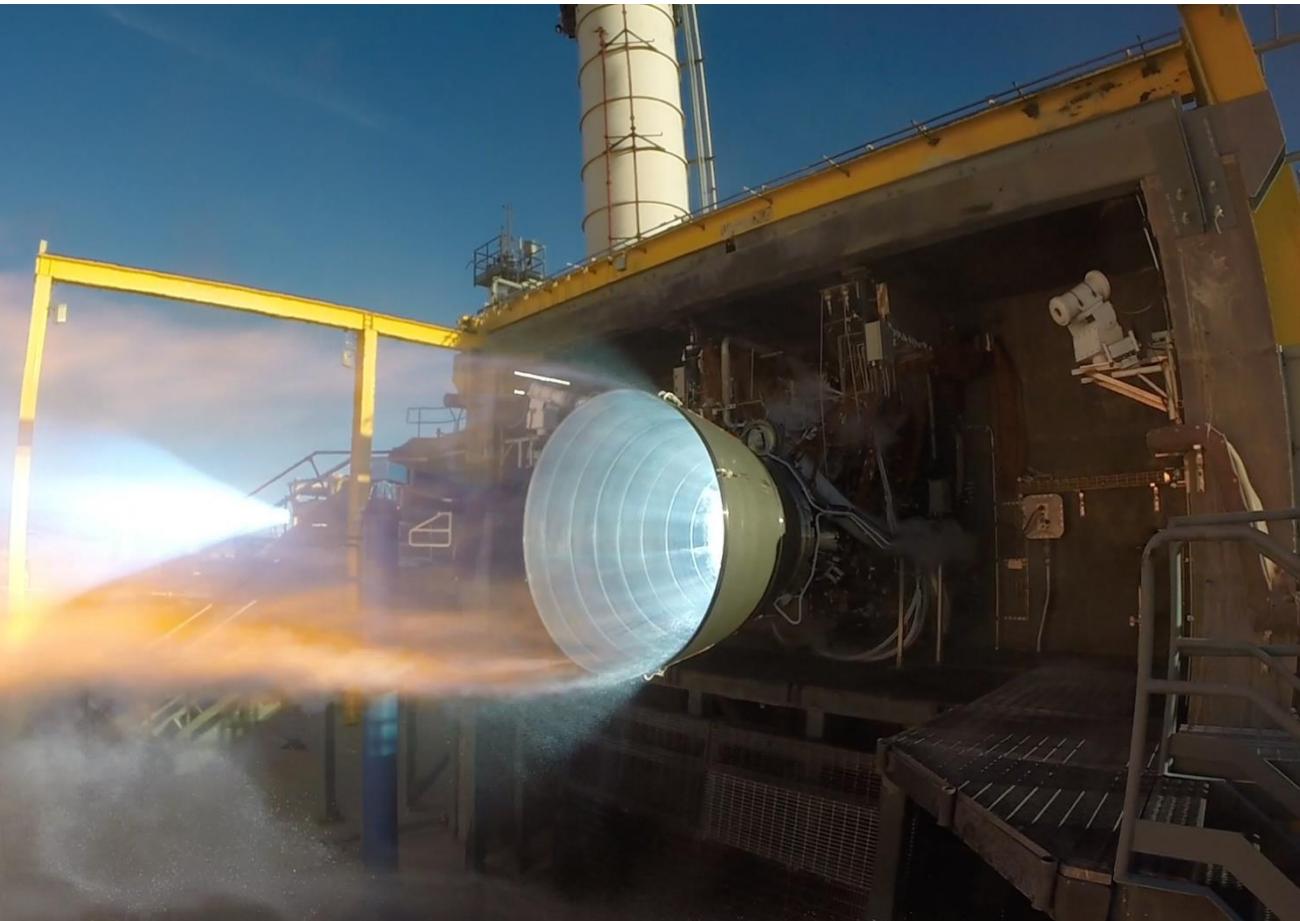


Figure 1-1 New Glenn launch system

before and during flight. The PLF pairs with a fixed adapter and accompanying industry-standard payload interface for easy interoperability with modern spacecraft (SC) busses. New Glenn offers a 7 m (23 ft) diameter PLF.

Figure 1-2: Blue Engine 4 (BE-4)



Propulsion technology is foundational to the New Glenn program. New Glenn benefits from more than a decade of engine and related technology development at Blue Origin. Beginning with the BE-3, a 490 kN (110,000 lbf) sea level thrust liquid oxygen/liquid hydrogen (LOX/LH₂) engine used to power New Shepard, Blue Origin has demonstrated reliable, frequent reuse and deep throttling capability. The BE-3 has amassed significant test heritage totaling over 54,000 seconds of runtime and over 650 starts since development began in 2010.

For New Glenn's first stage, Blue Origin will use the BE-4, a 2,400 kN (550,000 lbf) sea level thrust booster engine, pictured in Figure 1-2. The BE-4 uses LOX and liquefied natural gas (LNG), a commercial form of methane, as an affordable, clean, and operable propellant combination. Industrial-grade LNG is plentiful and inexpensive, and its use allows for autogenously pressurized tanks and elimination of helium as a pressurant.

New Glenn's second stage will be powered by a higher performing, vacuum-optimized variant of the flight-proven BE-3 engine, the BE-3U. Two BE-3U engines will generate a total of 1,060 kN (240,000 lbf) of vacuum thrust. The BE-3U uses LOX and LH₂ for high efficiency in-space propulsion, enabling highly energetic performance for missions beyond LEO.

Development testing of both the BE-4 and BE-3U is currently underway at Blue Origin's engine test site in West Texas.

New Glenn will operate from a new commercial orbital launch site at Cape Canaveral Air Force Station (CCAFS), Florida. Florida operations will also include a complex for launch and mission control, as well as manufacturing and assembly of the launch vehicle's (LV) first and second stages, fixed adapter, and PLF. The facility is situated in Exploration Park, located adjacent to the NASA Kennedy Space Center (KSC) main entrance.

A future New Glenn launch site for high inclination LEO missions is planned at Vandenberg Air Force Base.

In addition to launch vehicle manufacturing, Blue Origin and partner facilities will span pre-launch payload processing and integration, engine testing and acceptance stands, and first stage recovery and reuse. For more information on facilities, see Section 8.0: Facilities.

1.2 SYSTEM CHARACTERISTICS

1.2.1 First Stage

The New Glenn primary booster is an operationally reusable first stage with a length of 57.5 m (188.5 ft) and a tank diameter of 7 m (23 ft). The stage consists of three (3) sections: aft, mid, and forward, as shown in Figure 1-3.

The aft module of the booster contains seven (7) BE-4 LOX/LNG engines with 1.71×10^4 kN (3,850,000 lbf) total thrust at sea level. The restartable BE-4 engines provide precision thrust vector control and continuous deep throttle capability to support propulsive deceleration and landing maneuvers, while featuring long design life. The 8.5 m (28 ft) diameter engine skirt protects the engines from atmospheric reentry conditions and contains six (6) stowed landing gear.

The mid module of the booster houses the fuel (LNG) and oxidizer (LOX) tanks. The tanks are made of orthogrid aluminum and are designed to withstand the high g-loads realized during reentry. Large aerodynamic strakes on the aft end of the tanks give the returning first stage enhanced cross-range during descent and reentry.

The forward module of the booster features four (4) actuated aerodynamic control fins for attitude control during descent. This section of the booster also provides ground umbilical connections for New Glenn and interstage housing of

the two second stage vacuum-optimized BE-3U engines. The forward module houses various guidance navigation & control avionics, including an autonomous flight safety system. The pneumatic pusher stage separation system, which provides positive separation before second stage ignition, is located in the forward module.

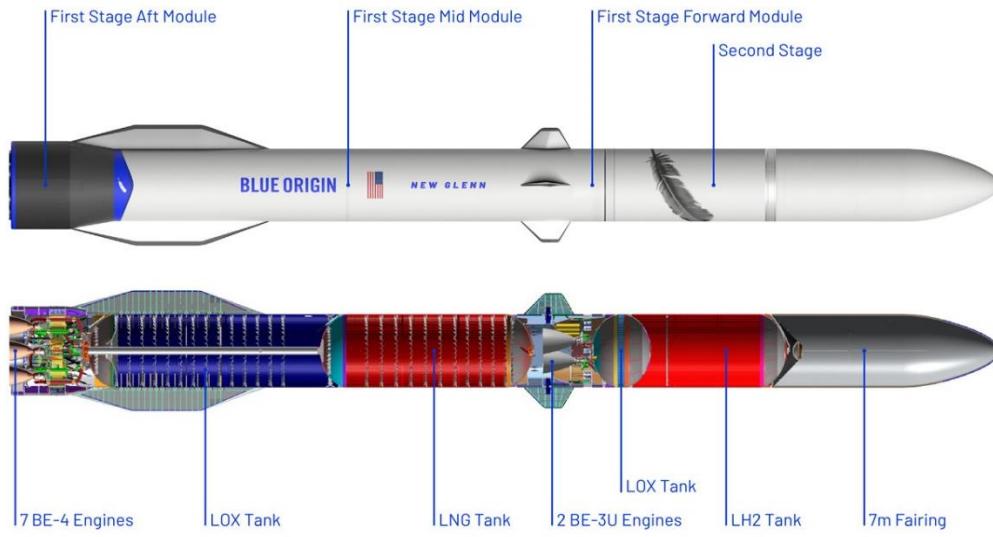


Figure 1-3: New Glenn two-stage configuration

1.2.2 Second Stage

The second stage is an expendable LOX/LH₂ stage with dual gimballing BE-3U engines with 1,060 kN (240,000 lbf) total thrust in vacuum. The stage also has a tank diameter of 7 m (23 ft) and uses common tooling with the first stage to reduce recurring cost. The length of the second stage tank is 16.1 m (52.9 ft) and the overall length including the two high expansion ratio nozzle BE-3Us is 23.4 m (76.9 ft). Similar to the first stage, the second stage has aft, mid, and forward sections.

The aft section consists primarily of the two BE-3U engines, associated load bearing cross-bar thrust structure, and tankage/equipment for long duration operations. The reaction control system (RCS)/settling system uses tri-axial thrusters distributed in four places along the thrust structure. The second stage aft section integrates with the first stage forward section and provides one of two(2) second stage umbilical interfaces.

The mid-section contains all propellant tankage including a forward LH₂ tank and an aft LOX tank, separated by a common insulated bulkhead. The tank barrels are orthogrid aluminum construction, and the domes are constructed from welded aluminum. A single external insulated LH₂ supply line passes around the LOX tank.

The forward section consists of the LH₂ tank forward skirt and a circumferential avionics shelf integrated with the forward dome. The skirt provides the primary mechanical interfaces to the payload accommodations, including a jointed interface between the composite fixed adapter and the PLF.

See Table 1-1 for an overview of the two-stage New Glenn's key physical system characteristics.

Table 1-1: Two-stage New Glenn system characteristics

Element	First Stage	Second Stage
Stage Height	57.5 m (188.5 ft)	23.4 m (76.9 ft)
Vehicle Height, incl. PLF	96 m (313 ft)	
Tank Diameter	7 m (23 ft)	
Tank Type	Aluminum, orthogrid tanks	
Aerodynamic Surfaces	4 fins, 2 strakes	n/a
Engine	BE-4	BE-3U
Engine Type	Oxygen-Rich Staged Combustion	Open Expander Cycle
Engine Designer	Blue Origin	
Number of Engines	7	2
Stage Thrust	1.71×10^4 kN (3,850,000 lbf) sea level	1,060 kN (240,000 lbf) vac.
Propellants	LOX/LNG	LOX/LH ₂
Pressurization	Autogenous	
Throttleability	45% to 100% continuous	88% to 100% continuous
Restartable	Yes	4 burns

1.2.3 Third Stage

Reserved.

1.2.4 Reusability

The reusable component of the New Glenn launch system is its first stage, including its seven (7) BE-4 engines. After second stage separation, the first stage booster reorients itself to reenter the atmosphere aft end first. Through a combination of aerodynamics and propulsive maneuvers, the stage performs a precision landing on the ocean-going platform in the Atlantic Ocean, as shown in Figure 1-4.

After recovery at sea, the booster returns to the launch site via Port Canaveral for inspection and reuse.



Figure 1-4: First stage landing and recovery on ocean-going platform

1.2.5 Single Configuration

New Glenn uses the same all liquid propellant system configuration to perform a wide range of highly energetic missions without the need for solid rocket motors or multiple cores that can impact system reliability. New Glenn is a single core design and has only three (3) unique separation events for a dedicated mission (second stage, PLF, and payload) compared with up to ten (10) with other launch systems. By using a single configuration for all missions and an operationally reusable first stage, New Glenn will rapidly accumulate flight heritage and operational economies of scale.

1.3 CONCEPT OF OPERATIONS

Typical New Glenn launch services begin with Launch Services Contract (LSC) signing approximately 24 months or less before launch, depending on manifest availability and Blue Origin's experience with a given payload. A mission integration period follows LSC signing. As described in Section 6.0: Integration, mission integration includes mission planning, design, and analysis activities, before concluding with payload integration and a launch campaign. A typical month-long campaign allows more than three (3) weeks of independent payload processing and preparations followed by one (1) week of combined operations with the payload and launch vehicle. Combined operations include payload encapsulation, transportation to the launch site, horizontal integration to the

launch vehicle, and finally, rollout to the launch pad and launch on the same day. Campaigns longer than 30 days are possible as part of optional launch services.

The New Glenn operating concept is designed to support 12 missions per year with a single dedicated launch site. To account for seasonal weather variations, the New Glenn launch system is capable of surging to eight (8) missions within a four (4) month period and three (3) missions within a single month. This launch cadence requires only a single launch pad, landing platform, and integrated transporter erector (TE) with umbilical mast. See Section 7.0: Operations for more information on New Glenn operations.

1.4 CUSTOMER INTERFACE

Blue Origin strives for responsive customer service with a dedicated commercial and government sales force and a single point of contact from LSC signature through delivery in orbit and post launch review.

Blue Origin provides a Customer Integration Director (CID) as the interface to support the customer's launch services experience. All communications start with the CID and follow a well-defined mission integration process, as described in Section 6.0: Integration.

The CID is responsible for coordination of all elements and deliverables within the LSC statement of work. The CID works with the Blue Origin team to support the mission, including launch operations, mission integration, safety and mission assurance, contracts and legal, and administration.

1.5 STANDARD LAUNCH SERVICES

New Glenn standard launch services include comprehensive engineering, management, and operational support designed to encompass the customer's needs. All standard launch services are detailed in the statement of work (SOW) provided with the LSC. A representative summary of New Glenn standard launch services is highlighted in Table 1-2 below.

Table 1-2: Standard launch services

Service Type	Standard Launch Service
Customer Integration	Schedule, interface control document (ICD) development, U.S. government coordination, mission assurance
Technical Reviews	Interchange meeting, ground operations, mission design, mission readiness
Engineering Analyses	Coupled load, acoustic, dynamic, trajectory, interfaces, separation, electromagnetic, etc.
Launch Vehicle Hardware & Flight Software	PLF, PLF doors or radio frequency (RF) windows, payload adapter system (PAS), customer branding/logo graphics

Service Type	Standard Launch Service
Launch Operations	Launch campaign/event coordination, combined operations support, dress rehearsal, etc.
Support Services	Transportation, ground support equipment, communications, safety, timing, etc.
Facilities	Payload processing facilities (PPF), offices, equipment storage, etc.

Additional mission-unique hardware, software, technical analysis, operations, and facilities are available as optional launch services, and are detailed in the SOW. A representative summary of New Glenn optional launch services is highlighted in Table 1-3 below.

Table 1-3: Optional launch services

Service Type	Optional Launch Service
Customer Integration	Non-standard launch windows
Technical Reviews	Additional meetings or review cycles, enhanced mission assurance
Engineering Analyses	Additional analysis cycles, customer site PAS fit-check and shock test
Launch Vehicle Hardware & Flight Software	Re-radiation communications, more PLF doors/windows, instrument purges, etc.
Launch Operations	Additional rehearsals, enhanced photo/video and customer experiences, etc.
Support Services	Enhanced PPF cleanliness, propellant loading, shipping/packing, etc.
Facilities	Additional office space, 50 Hz power, long-term equipment storage, etc.

1.6 MISSION ASSURANCE

Blue Origin's approach to system safety and reliability is embodied in the company's mission assurance philosophy, contained in the company's Mission Assurance Plan:

The safest and most reliable vehicles are robust, well understood machines developed in a culture of accountability, discipline, and attention to detail.

This culture of mission assurance increases the probability of safe and successful operations. Mission assurance is the responsibility of all Blue Origin employees.

Blue Origin proactively manages safety through safety engineering, hazard identification/ mitigation, and quality processes. All systems are designed, built, and operated using system safety analysis methodologies under processes for

hazard communication, hazardous material handling, personnel safety, and environmental management. Quality is a core value at Blue Origin. The team believes that system success is influenced by culture, management decisions, and the actions of individual technicians and operators. Quality is deeply embedded in the design, fabrication, testing, and operation processes of all systems. A commitment to quality processes and procedures drives toward error-free design products, a known configuration of each flight vehicle, and defect-free workmanship.

System safety requirements drive the design of Blue Origin's systems. The most recognizable types of system safety requirements are reliability and fault tolerance. System safety requirements also include safety factors, independence and separation requirements, as well as requirements for monitoring, procedures, and development software/firmware rigor.

At the most basic level, the New Glenn system is designed for stable and controlled flight, limiting the flight environments to those acceptable for spacecraft, while satisfying all launch and recovery regulatory requirements. Payloads also benefit from key mission critical reliability requirements, such as:

- Single-failure tolerance against faults that would prevent achieving the desired customer experience, otherwise meeting specified payload requirements, or recovering reusable system elements without needing major repair
- Single-sensor loss tolerance during pre-launch preparations for sensors that would cause a delay of mission

2.0

PERFORMANCE

2.0 PERFORMANCE

This section characterizes the performance of the New Glenn reusable launch vehicle for expected mass to orbit capability. Information is also provided on injection and pointing accuracy and mass properties requirements.

Note that until the initial New Glenn flight, all predicted vehicle performance and payload environment data within the Payload User's Guide (PUG) are design targets to be validated through the vehicle and engine development program, and thus are subject to change.

2.1 LAUNCH SITE

The New Glenn orbital launch site at Launch Complex 36 (LC-36) at Cape Canaveral Air Force Station (CCAFS), is located on the Florida Space Coast at latitude of 28.5° N.

LC-36 offers:

- A wide range of available launch azimuths and orbital inclinations (see Figure 2-1)
- Low inclination and corresponding high mass to orbit
- Low flight safety risk requirements

For more detailed information on the orbital launch site, see Section 8.1.3: Launch Complex.

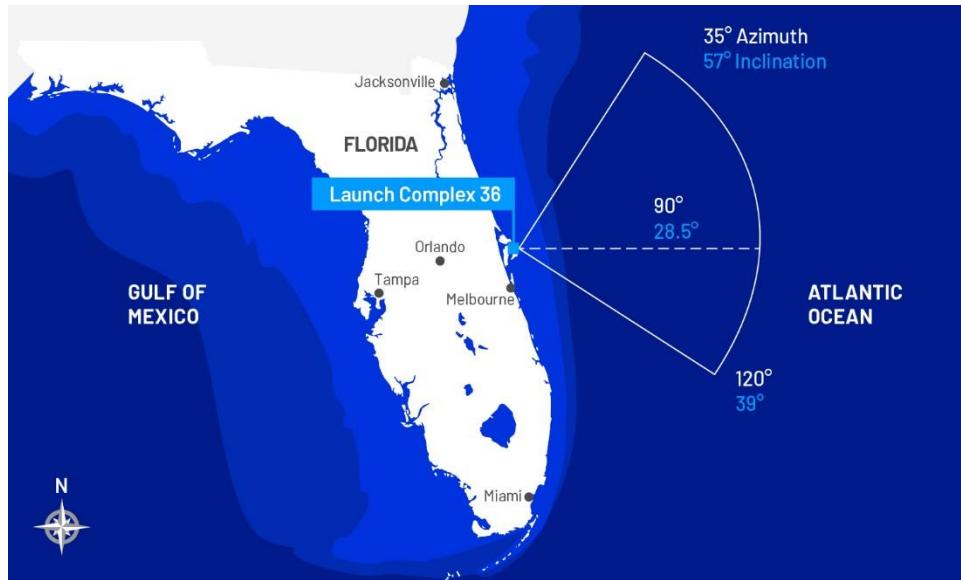


Figure 2-1: Available azimuths and inclinations from LC-36, Cape Canaveral, FL

2.2 MISSION PROFILE

Most missions to Low Earth orbit (LEO), geostationary transfer orbit (GTO), and elsewhere follow similar mission profiles. In the final seconds before liftoff, the seven (7) BE-4 engines on the first stage ignite in advance of an automated final go/no-go determination. The engines throttle up to partial thrust, at which point built-in-test diagnostic software analyzes the performance and health of each engine. Upon verification of nominal conditions, the flight computer issues a final "commit to launch" command, which permits full engine throttle. The transporter erector (TE) tips back out of the flight cone, hold down mechanisms release, and New Glenn lifts from the launch pad, detaching all launch vehicle umbilicals.

Following liftoff, the typical New Glenn mission profile is illustrated in Figure 2-2.

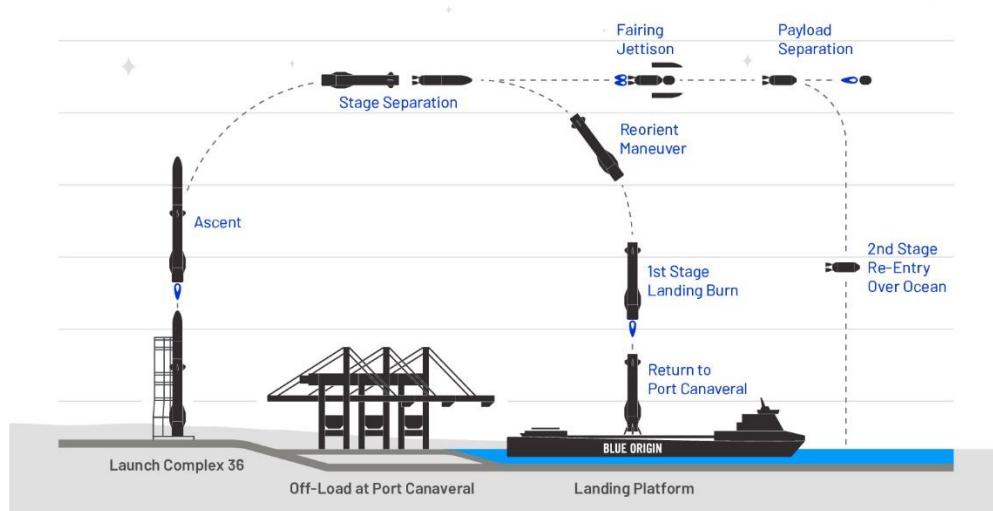


Figure 2-2: Typical New Glenn mission profile

For a nominal 250 km perigee altitude GTO mission, the first stage booster initiates an engine shutdown sequence at a mission elapsed time (MET) of 199 seconds. The command induces the BE-4 main engine cut-off (MECO), and thrust tails off until second stage separation occurs at MET 202 seconds. The first stage then reorients for atmospheric reentry, landing, and recovery.

The first burn for the second stage BE-3U engines starts once adequate distance between the stages is achieved, at approximately MET 206 seconds. Once passing the desired limit for aerodynamic heat flux to the payload at approximately MET 216 seconds, the payload fairing (PLF) is jettisoned and the stage continues to sustain powered flight with the un-encapsulated payload. The engines burn for 618 seconds before second stage engine cut-off (SECO-1) at MET 824 seconds. Near perigee, the BE-3U engines relight at approximately MET

1702 seconds for 99 seconds to initiate a Hohmann transfer along with a minor inclination change. In the GTO mission example, the vehicle coasts for 180 seconds after SECO-2 before initiating payload separation. See Figure 2-3 below for an illustration of the standard Blue Origin GTO injection.

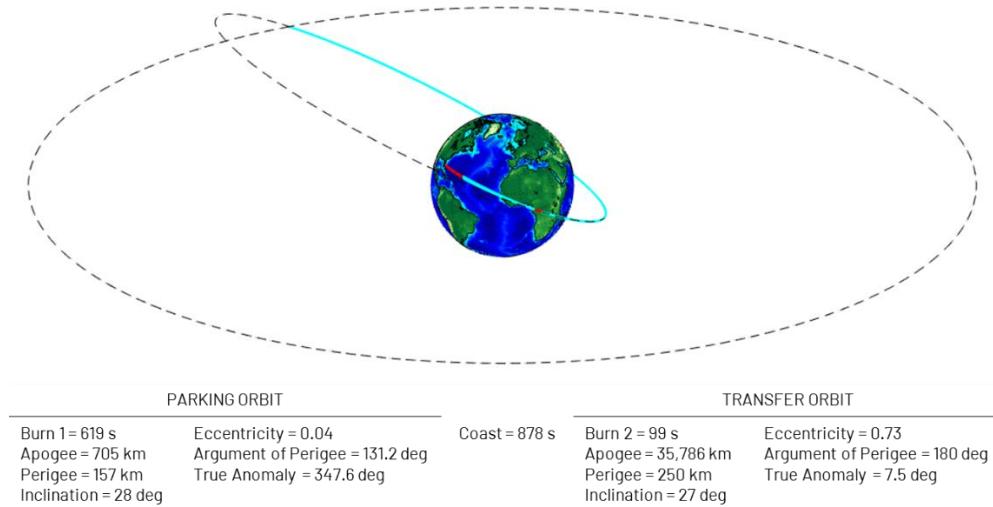


Figure 2-3: Example standard GTO second stage injection sequence

Depending on the desired orbital insertion, the duration and quantity of vehicle coasts and BE-3U re-ignitions vary. The second stage has long duration (11+ hours) coast capability and can start the engines up to four (4) times. During coast phases, the second stage performs attitude and spin rate adjustment maneuvers as required to address thermal heating and solar angle criteria, before releasing the payload for orbit insertion. In elliptical transfer orbit trajectories, on-board spacecraft propulsion completes orbit-raising and/or circularization of the spacecraft into the final orbit. In a circular trajectory, the second stage engines typically start three (3) times, including a circularization burn at apogee of the transfer orbit prior to payload separation. A fourth burn may be needed to ensure proper stage disposal, depending on the orbital parameters.

Telemetry from the launch vehicle is available using space-based communication networks through all or most phases of ascent, depending on the mission. Telemetry includes, at a minimum, critical events such as payload separation, and most events in Table 2-1.

Once the second stage has delivered the payload and executed any necessary contamination and collision avoidance maneuvers (CCAM), it waits to maneuver for disposal by reentry. Typically, a retrograde maneuver, such as tank venting or other propulsive event, is performed a half orbit before the reentry point, which is selected where altitude is low enough that breakup is over a predictable area with no safety impacts. Depending on mission parameters, the retrograde

maneuver takes place anywhere from 27 minutes after MECO for low-altitude LEO missions to five (5) hours or more after MECO for GTO missions. LEO and GTO missions follow different mission profiles, which are detailed in Table 2-1 below.

Table 2-1: Notional mission profile timelines for LEO, GTO

Event	MET – LEO	MET – GTO
Engine ignition	-2 s	-2 s
Liftoff	0 s	0 s
MECO	198 s	199 s
Stage separation	201 s	202 s
Second engine start	205 s	206 s
Fairing separation event	215 s	216 s
SECO-1	805 s	824 s
Second engine second start	-	1,702 s
SECO-2	-	1,801 s
Payload separation event	985 s	1,981 s

2.3 INITIAL OPERATIONAL CAPABILITY

New Glenn is still in design and development, and initial launches are planned to carry conservative flight performance reserves for enhanced service reliability and vehicle recoverability. Blue Origin may model mission performance with off-nominal engine performance, dry mass allocation exceedances, reduced maximum reentry environments, and other assumptions that ensure recovery of the first stage, all of which result in a temporary decrement of mass to orbit.

As vehicle performance is validated through early missions, Blue Origin will release reserves incrementally until later flights operate at nominal design points and full New Glenn performance is attained.

Please contact Blue Origin for initial mass to orbit capabilities and to discuss specific, desired orbital parameters.

2.4 FULL OPERATIONAL CAPABILITY

Performance figures below represent full operational payload capabilities to generic orbits, and are inclusive of both the separated payload mass and any payload adapter, dual manifest structure, or dispenser system. All estimates take into account second stage disposal within 25 years in accordance with United States space policy and industry best practices.

2.4.1 Low Earth Orbit

The New Glenn two-stage launch vehicle is specified to ultimately deliver a payload mass of up to 45,000 kg (99,000 lbm) to LEO with a circular altitude of at least 200 km and with an inclination of 51.6°.

Please contact Blue Origin for specific performance and capabilities information.

2.4.2 Geostationary Transfer Orbit

The New Glenn two-stage launch vehicle is specified to deliver a payload mass of up to 13,600 kg (30,000 lbm) to GTO with an apogee altitude of 35,786 km, a perigee altitude of at least 185 km, and with an inclination of 27°. An example standard GTO mission ground trace through payload separation is shown in Figure 2-4 below.

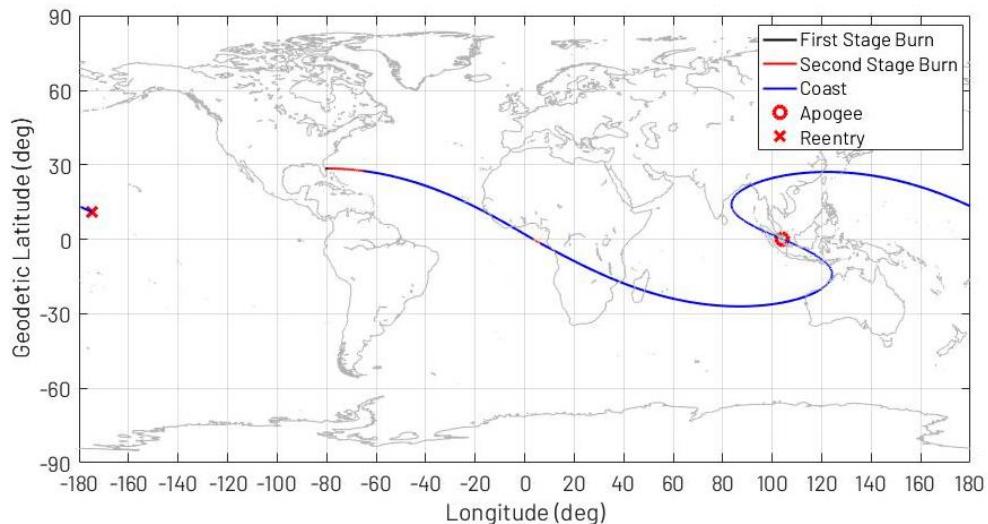


Figure 2-4: Notional GTO mission ground trace

A standard GTO mission profile showing altitude and relative velocity corresponding to timelines in Table 2-1 is shown in Figure 2-5 and Figure 2-6 below.

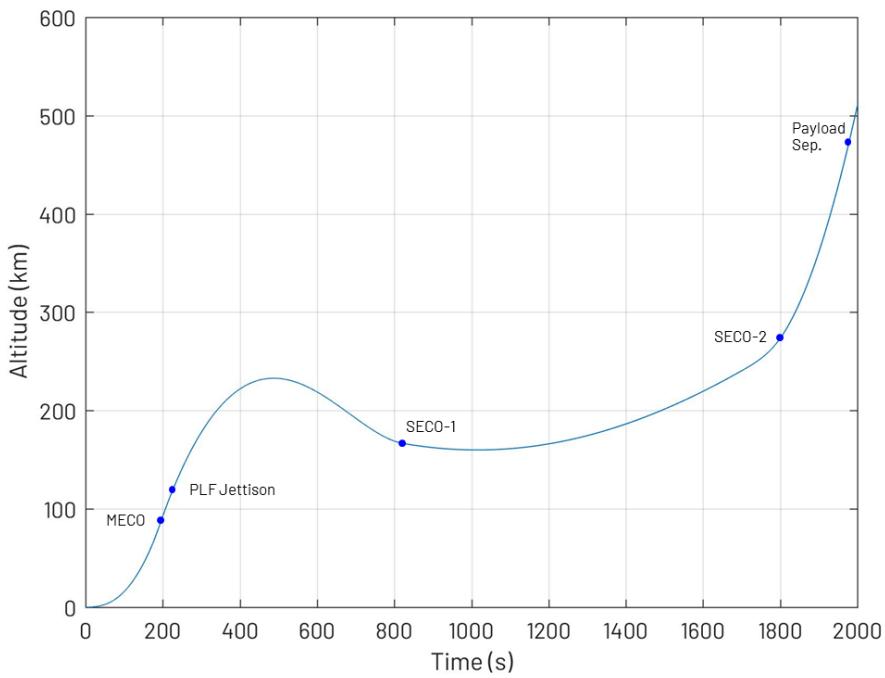


Figure 2-5: Notional GTO mission altitude profile

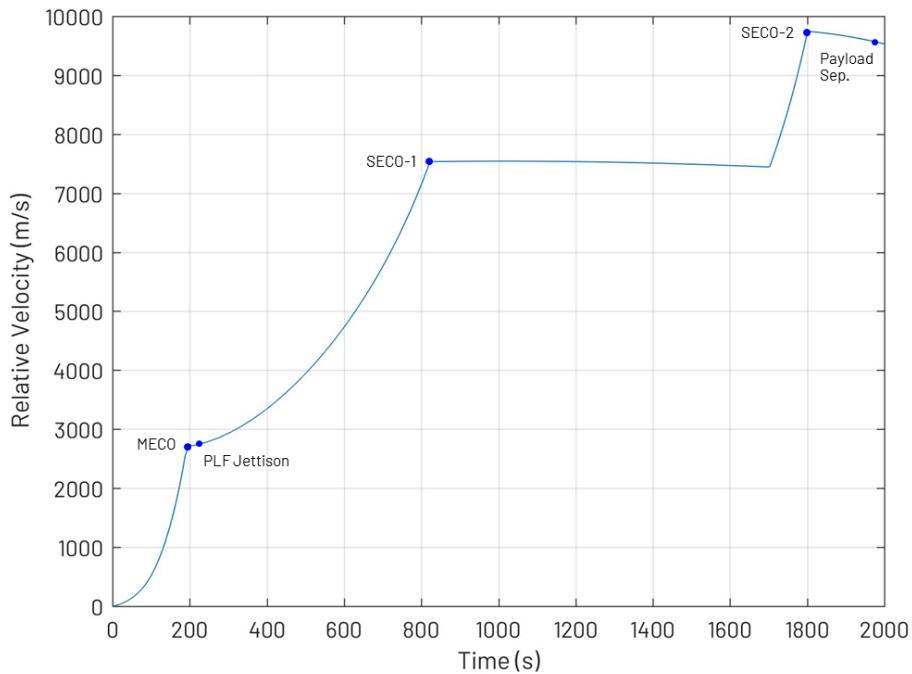


Figure 2-6: Notional GTO mission relative velocity

Nominal delta velocity (ΔV) remaining to geosynchronous equatorial orbit (GEO) or geostationary orbit via standard Hohmann GTO transfer when launched from

LC-36 to 27° is approximately 1,800 m/s (5,905 ft/s). Depending on the mass of the payload as well as requirements for apogee and perigee, alternate insertion strategies such as supersynchronous or subsynchronous transfer may be selected to maximize the payload mass or lifetime and minimize ΔV remaining to GEO. Please contact Blue Origin for specific performance and capabilities information.

2.5 DUAL MANIFEST CAPABILITY

As part of Blue Origin's strategy to enhance the long-term economics of spaceflight, New Glenn will be able to carry any combination of two (or more) payloads on a single launch to a common orbital destination, thereby reducing the per spacecraft cost to orbit, particularly for large spacecraft masses. The approach uses a lightweight carrying structure internal to the PLF (as described in Section 5.4: Dual Manifest Structure) designed to envelope a lower position or "berth" payload and support an additional upper berth payload, either with a mass of up to 10,000 kg (22,000 lbm). Each payload berth meets the same environmental and interface requirements as a standard capacity single manifest launch. In addition, with a 7 m fairing, most spacecraft will be interchangeable between berths, simplifying co-passenger manifesting.

Accounting for the mass of the dual manifest structure, payload pairing combinations to a standard GTO with a perigee of 250 km and inclination of 27° exist on a spectrum of acceptable masses, as per Section 3.1.1: Mass Ranges and as shown in Table 2-2 below. The target mass is up to 6,200 kg (13,680 lbm) per payload to enable the greatest flexibility in pairing with other small, medium, or large-sized payloads. A large 9,000 kg (19,800 lbm) spacecraft can still be launched in dual manifest, however it requires pairing with a smaller co-passenger to ensure compatibility with overall vehicle performance.

Table 2-2: Separated mass to GTO in dual manifest

Pairing Scenario	Lower Berth Payload kg (lbm)	Upper Berth Payload kg (lbm)
Typical GTO	6,200 (13,680)	6,200 (13,680)
Min-Max GTO	2,270 (5,000)	10,000 (22,000)
Max-Min GTO	10,000 (22,000)	2,270 (5,000)

Exact New Glenn performance will depend on the desired orbital parameters, particularly if pairing payloads in very different orbits (e.g., LEO and GTO, or GTO and TLI). Blue Origin expects to begin offering dual manifest capability shortly after the initial missions of New Glenn. Please contact Blue Origin for more information on availability of dual manifest, or for performance in dual manifest to other orbital destinations.

2.6 ORBITAL INJECTION ACCURACY

Blue Origin is designing New Glenn to achieve orbital insertion accuracies as shown in Table 2-3 below.

Table 2-3: Orbital injection accuracy

Orbit	Apogee Altitude	Perigee Altitude	Inclination	Arg. of Perigee Accuracy	RAAN Accuracy
LEO	$\geq 200 \text{ km}$ $\pm 15 \text{ km } 3\sigma$	$\geq 200 \text{ km}$ $\pm 7.4 \text{ km } 3\sigma$	$28 - 51.6^\circ$ $\pm 0.12^\circ 3\sigma$	(circular)	$\pm 0.1^\circ 3\sigma$
GTO	35,786 km $\pm 200 \text{ km } 3\sigma$	$\geq 185 \text{ km}$ $\pm 7.4 \text{ km } 3\sigma$	$\leq 27^\circ$ $\pm 0.05^\circ 3\sigma$	$\pm 0.3^\circ 3\sigma$	$\pm 0.4^\circ 3\sigma$

2.7 ATTITUDE CONTROL

New Glenn has full 3-axis pointing and rotation capability during the payload separation phase of a mission, and can separate payloads with or without spin according to customer requirements. Launch vehicle axes are defined in Section 5.1: Vehicle Axes Definition.

The launch vehicle is capable of orienting relative to a variety of reference frames, including the following payload attitude reference frames:

- o Earth centered inertial
- o Earth centered, Earth fixed
- o Local vertical, local horizontal

The upper stage coasts between maneuvers for a nominal duration between 18 minutes and 5.25 hours using the standard configuration of batteries and thermal protection. Depending on the mission profile, mission kits can augment power, reaction control, thermal, and radiation protection systems to extend coast durations to 11 hours or longer, with associated impacts to payload mass. Shorter coasts can also be designed on a mission-unique basis. To accommodate payload illumination and thermal requirements during coast periods, New Glenn is capable of accurately orienting the launch vehicle roll axis (X-axis) in any selected direction and rotating about it at a selected spin rate up to $3.0^\circ/\text{s}$ in either direction, as described in Table 2-4 and Table 2-5 below.

Table 2-4: Attitude control pointing accuracy

Parameter	Coast Phase	Separation Phase
X-Axis (Spin/Roll) Pointing Accuracy	$\pm 5^\circ$	$\pm 1^\circ 3\sigma$
Y and Z Axes (Pitch/Yaw) Pointing Accuracy	Not specified	$\pm 1^\circ 3\sigma$

Table 2-5: Attitude control rotation capability

Parameter	Coast Phase	Separation Phase
X-Axis Rotation(Spin/Roll Rate)	Up to 3.0°/s	Up to 2.5°/s
Y and Z Axes Rotation(Pitch/Yaw Rate)	Not specified	Up to 2.5°/s
X-Axis Rotation Accuracy(Spin-stabilized Roll Rate Error)	± 0.5°/s	± 0.3°/s $3\sigma^*$
Y and Z Axes Rotation Accuracy(Spin-stabilized Pitch/Yaw Rate Error)	Not specified	± 0.3°/s $3\sigma^*$
X-Axis Rotation Accuracy(3-axis Stabilized Roll Rotation Rate Error)	Not specified	± 0.25°/s 3σ
Y and Z Axes Rotation Accuracy(3-axis Stabilized Pitch/Yaw Rotation Rate Error)	Not specified	± 0.1°/s 3σ

*For a maximum 127 mm (5 inch) payload lateral center of gravity (CG) offset aligned with any selected direction in the payload body frame and any selected direction in the separation attitude reference frame

The upper stage can separate payloads in any selected attitude to within 1° per axis. Separation occurs either while 3-axis stabilized or with a selected spin rate up to 2.5°/s about the launch vehicle spin axis. Rotation accuracies for spin-stabilized or 3-axis stabilized separations are described in Table 2-5. The separation spin rate may be aligned with any selected direction in the launch vehicle body frame and any selected direction in the payload's desired attitude reference frame.

Separation attitude accuracy varies with the selected separation system, or payload adapter system (PAS). Table 2-4 and Table 2-5 above summarize expected performance with a range of standard commercial off-the-shelf (COTS) PAS. Specifications for Blue Origin-provided PAS are described in Section 5.3.2: Payload Adapter System.

Payload velocity at separation is dependent on the design and calibration of the separation system's release mechanism (e.g., separation springs). The standard COTS PAS imparts a minimum ΔV of 0.3 m/s (1 ft/s) to the payload relative to the upper stage upon separation.

3.0 REQUIREMENTS

3.0 REQUIREMENTS

Blue Origin's customers and spacecraft manufacturer partners should plan to meet the following spacecraft design requirements to ensure full compatibility with New Glenn. Formal compatibility agreements are in development with all major manufacturers to identify areas where mission-unique adaptations or waivers may be required on the most popular spacecraft platforms and buses.

This section does not cover requirements related to multi-spacecraft dispenser systems, or any other customer-furnished mission-unique hardware.

3.1 MASS PROPERTIES

3.1.1 Mass Ranges

New Glenn has two (2) baseline launch vehicle fixed adapter configurations, each of which results in a different amount of mass to orbit: a 1,575 mm (62 in) standard capacity bolt pattern, which is compatible with the most popular commercial-off-the-shelf (COTS) separation systems, and a larger 3,169.9 mm (124.8 in) high capacity bolt pattern with increased mass and moment capability.

The standard capacity configuration uses and includes a standard COTS clamp band payload adapter system (PAS) that is capable of handling payloads up to 10,000 kg (22,000 lbm). The high capacity configuration is used for payloads up to 37,200 kg (82,000 lbm), and provides only a launch vehicle structural interface for purposes of handling large customer-provided and/or mission-unique separation systems or dispensers. The high capacity configuration does not include a PAS or other separation system as part of standard launch services. A newly-developed COTS clamp band PAS designed for the high capacity configuration is expected to be available and flight-qualified in time for the first flight of New Glenn.

With either fixed adapter configuration, the minimum single manifest payload mass is 2,300 kg (5,000 lbm). The maximum single manifest payload mass (beyond the high capacity configuration) is determined by the maximum performance of the launch vehicle and the final desired orbital parameters, as per Section 2.4: Full Operational Capability.

Both fixed adapter configurations are shown in Figure 3-1 below, and more fully described in Section 5.3: Mechanical Adapters and Separation Systems. For other mission requirements not met by these two configurations, such as ultra-high capacity, multi-payload dispensing systems, or rideshare/auxiliary payload adapters, please contact Blue Origin for more information.

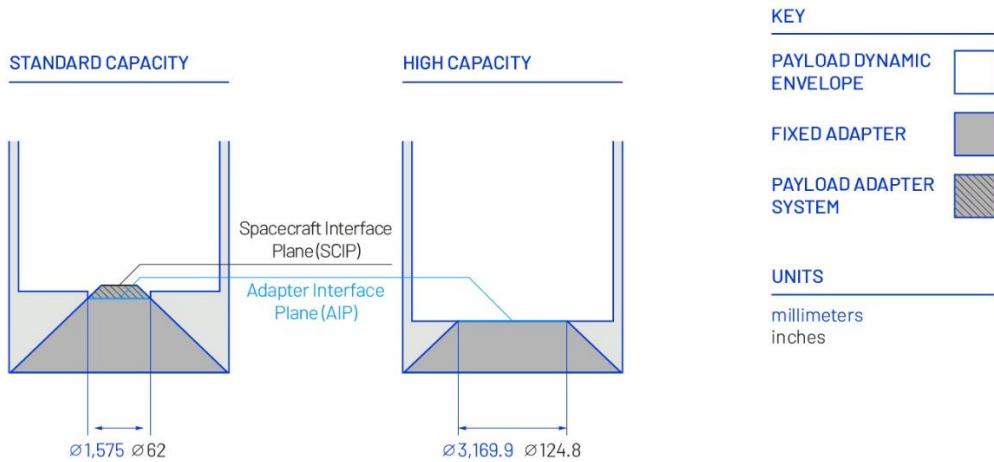


Figure 3-1: Standard capacity (left) and high capacity (right) configurations

3.1.2 Payload Center of Gravity

New Glenn's fixed adapters can support a combined payload and PAS that has a center of gravity (CG) above the adapter interface plane (AIP), (also known as the standard interface plane (SIP)), up to the axial distances in Figure 3-2 below. The fixed adapter also supports statically unbalanced payloads in single and dual manifest with a CG located up to 203.2 mm (8 in) laterally from the launch vehicle centerline. In the case of a dual manifest mission, the standard capacity curve applies to each AIP.

Note that the AIP forms the launch vehicle to PAS aft interface, which differs from the customer-selected PAS forward to spacecraft interface, called spacecraft interface plane (SCIP). Specifications for Blue Origin-provided PAS are described in Section 5.3.2: Payload Adapter System.

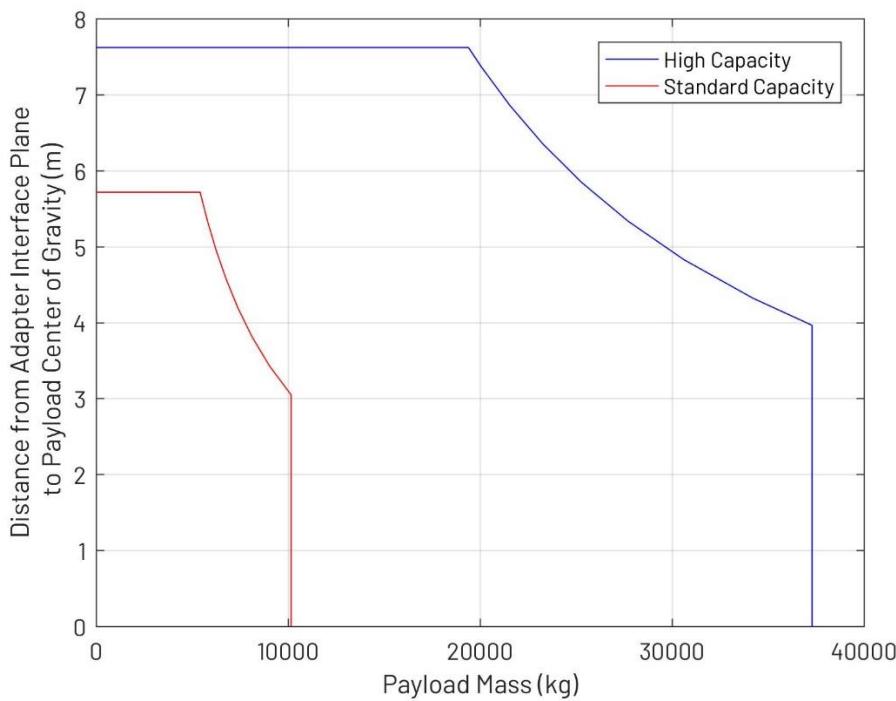


Figure 3-2: CG and mass properties above adapter interface plane

3.1.3 Fundamental Mode Frequencies

The payload's first and second structural bending modes must not be below the values listed in Table 3-1 to avoid adverse load coupling during standard flight assessments. Lower structural bending modes may be possible under certain circumstances, requiring more detailed analysis; please contact Blue Origin for more information.

Table 3-1: Payload fundamental frequencies

Lateral structural mode (Hz)	Axial structural mode (Hz)
≥ 6	≥ 15

A coupled loads analysis(CLA) of the payload stack conducted during the mission integration phase will provide more accurate characterization of the actual primary and secondary payload structural bending modes. A CLA will also produce specific predictions for structural load factors, bending moments and accelerations as inputs to customer design processes (See Section 6.4: Mission Integration Process for more information).

3.2 PAYLOAD TO LV SHOCK

In the event that the customer requires a mission-unique separation system, the acceptable payload-induced launch vehicle shock at the AIP interface with the

PAS must be limited to the accelerations shown in Table 3-2 and Figure 3-3 with 95% probability at 50% confidence and measured within 51 mm (2 in) of the AIP. Using a COTS PAS provided as a standard launch service and described in Section 5.3.2: Payload Adapter System satisfies this requirement.

Table 3-2: Allowable launch vehicle shock induced by the payload

Frequency (Hz)	Shock Response (G-Peak)
100	85
240	260
400	500
1400	5000
10000	5000

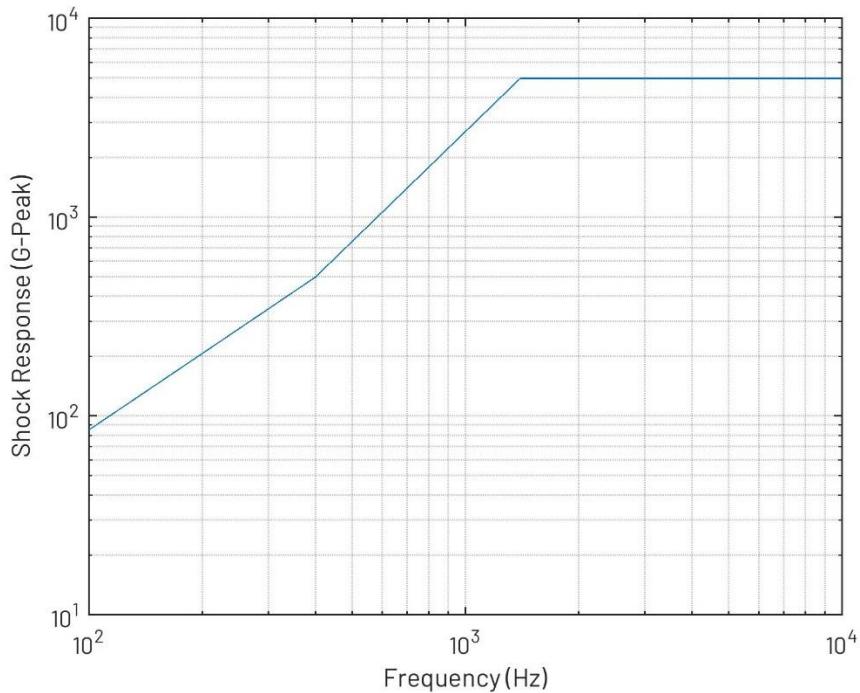


Figure 3-3: Allowable launch vehicle shock induced by the payload

3.3 PAYLOAD LINE LOADS PEAKING

Reserved.

3.4 PAYLOAD RADIATED EMISSIONS

Payloads must limit their electromagnetic (EM) emissions as measured at the AIP (free space radiating conditions) to no greater than the levels shown Table 3-3 and Figure 3-4 to avoid interference with launch vehicle radio frequency (RF) communication systems. This flight RF configuration must be maintained

between 90 minutes before launch until 20 seconds after separation of the payload is confirmed.

Table 3-3: Payload allowable radiated emissions / New Glenn RF susceptibility

Frequency Range (MHz)	E-field limit (dB μ V/m)	System
All Emissions	160	
< 1000	114	
1127 – 1327	46	GPS
1475 – 1675	46	GPS
400 – 470	75	
2025 – 2110	75	
2200 – 2300	130	New Glenn communications

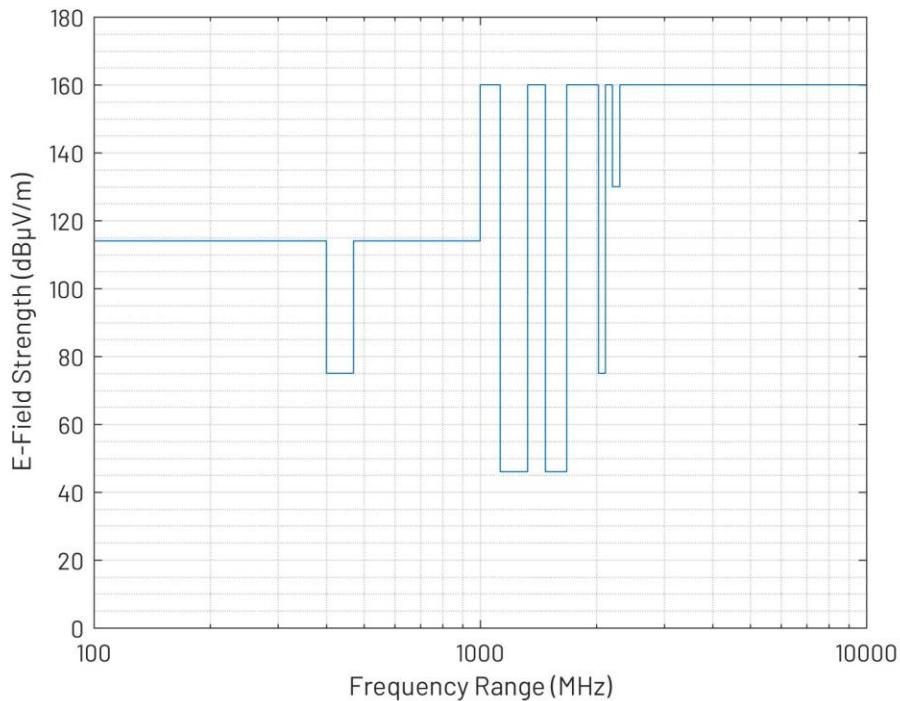


Figure 3-4: Payload allowable radiated emissions / New Glenn RF susceptibility

3.5 MATERIAL SELECTION FOR CONTAMINATION CONTROL

To minimize outgassing of non-metallic spacecraft materials, all payloads must meet these requirements when exposed to thermal vacuum:

- Less than 1% total mass loss (TML)
- Less than 0.1% collected volatile condensable material (CVCM)

Similarly, the payload volume environment contamination is limited to the same targets for TML and CVCM (see Section 4.2.4: Contamination Control, Flight).

Contamination levels are verified by analysis according to ASTM E595-15 Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment.

3.6 PAYLOAD VALIDATION AND VERIFICATION

As part of the mission integration process, the customer must present a validation and verification (V&V) plan that summarizes the approach to ensuring mechanical, electrical, and environmental compatibility. These efforts include analysis with appropriate design margins, qualification testing, protoflight testing, and acceptance testing. The customer must then demonstrate by inspection, analysis, and/or detailed qualification and acceptance test data that the payload and its ground systems are compatible with the expected flight and ground environments, as well as interfacing with the launch vehicle mechanical and electrical systems.

Payloads are most commonly tested to acceptance, protoqualification, and/or qualification limit levels for sine vibration, design loads, and shock. The customer may substitute random vibration testing for acoustic testing under certain circumstances. Blue Origin recommends customers also perform thermal cycling and thermal vacuum testing, as well as pressure venting analyses. The customer may elect to fly protoqualification units, to conduct qualification and acceptance testing on representative models, or a mixture of both approaches.

As part of standard launch services for the customer, Blue Origin provides an RF and electromagnetic compatibility assessment, as well as a pre-arrival PAS mechanical fit check analysis, including electrical connector compatibility. Upon payload arrival, Blue Origin also supports a brief PAS mechanical/electrical fit-check test. As part of optional launch services, the customer may request a physical hardware fit check at the customer's site.

During the formal reviews described in Section 6.4: Mission Integration Process, the proposed V&V approach and results must be approved. Blue Origin reserves the right to request more insight into testing and analysis processes, or to require more rigorous validation to ensure alignment with expected environments and interfaces.

Details and requirements may vary based on the level of acceptable risk to the payload. Please contact Blue Origin for more information on possible V&V approaches.

4.0 ENVIRONMENTS

4.0 ENVIRONMENTS

This section details the conditions that customer payloads may experience before, during, and after launch, based upon current launch system requirements and design analysis results.

The payload fairing (PLF) has several environmental control systems to protect payloads prior to launch and during ascent. These environmental subsystems include thermal protection, pressure venting, acoustic damping, and pre-launch environmental conditioning.

Note that unless otherwise specified, all environmental requirements and performance data reflect conditions at the adapter interface plane (AIP).

4.1 PRE-LAUNCH ENVIRONMENTS

4.1.1 Acceleration Loads, Ground Processing

The payload experiences accelerations while in transport between arrival and the payload processing facility (PPF), during combined operations processing at the PPF, during vertically-oriented transport between the PPF and the integration facility (IF) as shown in Figure 4-1, during horizontal breakover and mating to the launch vehicle in the IF, during rollout to the pad aboard the transporter erector (TE) (see Section 7.2: Pre-Launch Operations for more information), and during upending of the TE to vertical orientation at the pad.

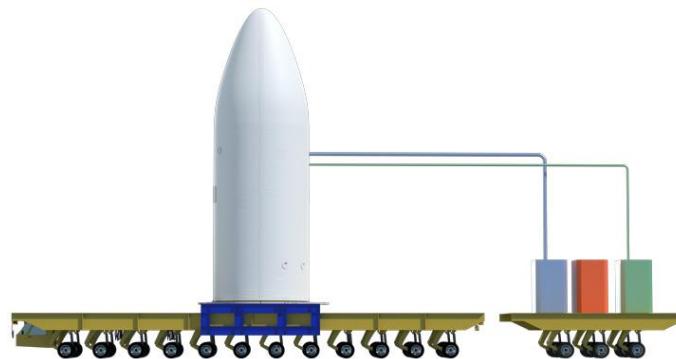


Figure 4-1: Encapsulated payload transport in vertical orientation

The maximum transportation and assembly loads on the payload will be limited to less than or equal to the levels in Table 4-1 below from payload encapsulation until liftoff, and will be further enveloped by flight environments.

Table 4-1: Maximum ground processing load factors

Transportation Mode	Vertical ($\pm g$)	Axial ($\pm g$)	Lateral ($\pm g$)
Hoist (w/crane, upward movement)	0.3	0.1	0.1
Crane Traverse (side to side)	0.2	0.2	0.2
Vertical Mating (stationary)	0.5	0.5	0.5
Rolling Cart (moving)	0.5	0.3	0.3
Air Pad (moving)	0.5	0.15	0.15
Transportation from PPF to IF in Vertical Orientation	0.5	0.25	0.25
TE transportation in horizontal orientation	0.5	0.5	0.5
Erecting, Rotation on TE (tilt 0° to 90°)	0.5 in direction of travel	0.5 in direction of travel	0.5 in direction of travel

Notes:

Vertical is in the direction of gravity, with positive down

Axial is in the direction of travel, if moving

Lateral is perpendicular to direction of travel, if moving, or otherwise perpendicular to vertical

All loads are limit loads without safety factors applied

Gravity is not included in load limits in this table

Erection and rotation on the TE occurs at 0.5°/s or less

Please contact Blue Origin for more information on specific transportation loading cases.

4.1.2 Thermal and Air Quality, Ground

The Blue Origin operations team controls the pre-launch thermal and air quality environments during all pre-launch operations and payload processing, beginning with the spacecraft arrival at the PPF. The PPF is maintained at consistent temperature, humidity and cleanliness standards as described in Table 4-2 below. Enhanced, mission-unique control of temperature, humidity and ECS cleanliness environments, such as those necessary for sensitive pyrotechnic operations, are possible for certain phases of payload processing operations as part of optional launch services. Please contact Blue Origin for more detailed PPF capability information.

To maintain the required thermal, humidity and cleanliness levels after encapsulation and PPF departure, a portable environmental control system (ECS) is connected to a port in the fairing. The port and related diffuser are arranged so that the airflow evenly distributes throughout the volume prior to exiting the PLF vent, and localized high velocity airflow is not detrimental to the payload. Airflow rate will be selectable such that the maximum conditioned air impingement velocity will be limited to between 3 m/s (10 ft/s) and 9.8 m/s (32 ft/s), although velocities outside this range may exist within the PLF volume.

The portable ECS provides Class 5,000 (ISO 6.7) cleanliness air to the payload volume, and is capable of controlling the flow of conditioned gas such that the desired internal temperature and flow impingement velocities are maintained. More volume and instrument purge capability with nitrogen gas of MIL-PRF-27401, Type 1, Grade B purity is available as part of optional launch services.

Within the controlled environments at the PPF, the payload's air temperature environment is maintained between 18 – 24 °C (65 – 75 °F) with supply air held to within 3 °C (5 °F) of a selected set-point. After encapsulation, the payload volume is maintained at less than 50% relative humidity, assuming the payload generates less than 2.95 kW (2.8 BTU/s) of heat.

While in transport between the PPF and the IF, local outdoor temperatures permit maintenance of the payload's air temperature environment between 10 – 29 °C (50 – 85 °F) with supply air held to within 3 °C (5 °F) of a selected set-point. The payload volume maintains less than 50% relative humidity, assuming the payload generates less than 2.95 kW (2.8 BTU/s) of heat. For special humidity-sensitive operations (e.g., pyrotechnic tasks) between encapsulation and mating to the launch vehicle, the relative humidity and temperature of the encapsulated volume can be maintained between 25% – 50% and between 10 – 21 °C (50 – 70 °F) respectively, as part of optional launch services.

Following mate of the encapsulated payload to the launch vehicle until liftoff, including during rollout to the pad, the payload's air temperature environment is maintained between 7 – 29 °C (45 – 85 °F) with supply air held to within 3 °C (5 °F) of a selected set-point. The payload volume maintains less than 50% relative humidity, assuming the payload generates less than 2.95 kW (2.8 BTU/s) of heat. For special humidity-sensitive operations (e.g., pyrotechnic tasks) between mating to the launch vehicle and liftoff, the relative humidity and temperature of the encapsulated volume can be maintained between 25% – 50% and between 7 – 21 °C (45 – 70 °F) respectively, as part of optional launch services.

Pre-launch thermal and air quality environments are summarized in Table 4-2.

Table 4-2: Standard thermal and air quality environments for spacecraft

Condition	Temperature	Relative Humidity	ECS Cleanliness	Assumptions
Un-encapsulated processing in PPF	18 – 24 °C 65 – 75 °F	50% ± 10%	100,000 ISO 8	n/a
Encapsulated processing in PPF	18 – 24 °C 65 – 75 °F	≤ 50%	5,000 ISO 6.7	Payload adds < 2.8 BTU/s
Encapsulated transport from PPF to IF	10 – 29 °C 50 – 85 °F	≤ 50%	5,000 ISO 6.7	Payload adds < 2.8 BTU/s
Encapsulated mating and integration in IF	10 – 29 °C 50 – 85 °F	≤ 50%	5,000 ISO 6.7	Payload adds < 2.8 BTU/s

Condition	Temperature	Relative Humidity	ECS Cleanliness	Assumptions
Encapsulated during rollout and at launch pad	7 – 29 °C 45 – 85 °F	≤ 50%	5,000 ISO 6.7	Payload adds < 2.8 BTU/s

4.1.3 Electromagnetic, Ground

Payloads experience a variety of electromagnetic (EM) fields generated by both the launch system and ambient launch range environment, which may cause potential interference with sensitive payload elements or materials. Blue Origin performs a launch vehicle electromagnetic compatibility assessment based on the payload's radiated emissions and New Glenn susceptibility as part of standard launch services. The customer is encouraged to perform their own compatibility testing to ensure operability within these radiated environments. For pre-launch and flight launch system radiated emissions and susceptibility, see Section 4.2.3: Electromagnetic.

4.1.3.1 Launch Range Radiated Emissions

The ambient EM environment is typically dominated by local ground communication and transmission at Cape Canaveral Air Force Station (CCAFS) near Launch Complex 36 (LC-36). The information listed in Table 4-3 below is based on data from recent surveys of the CCAFS radio frequency (RF) environment. The payload must tolerate the conditions in Table 4-3, as Blue Origin is not able to limit or mitigate these emissions, which are subject to change.

Table 4-3: Typical launch range emissions at LC-36

Launch Complex 36A – Cape Canaveral Air Force Station				
		Latitude: 28.4714° N Longitude: 80.5377° W		
Emitter	Peak	Average	Authorized Frequency (MHz)	Range (km)
Emitter 1	117.8	4.7	5650 to 5850	27.9
Emitter 2	150.9	3.8	5650 to 5850	4.0
Emitter 3	32.7	2.3	5650 to 5850	13.4
Emitter 4	153.6	6.1	5650 to 5850	13.4
Emitter 5	16.7	0.7	5650 to 5850	170.9
Emitter 6	5.8	0.2	9410 ± 30	5.7
Emitter 7	2.4	0.1	9410 ± 30	13.8
Emitter 8	2.0	0.0	9410	16.6
Emitter 9	0.9	0.3	2700 to 2900	48.7
Emitter 10	0.1	0.0	1030 to 1090	48.7
Emitter 11	1.5	0.3	1244.06 & 1326.92	50.0
Emitter 12	0.9	0.3	2750.5 & 2790	42.0

Launch Complex 36A – Cape Canaveral Air Force Station				
		Latitude: 28.4714° N		Longitude: 80.5377° W
Emitter 13	0.1	0.0	1030 to 1090	42.0
Emitter 14	3.9	0.1	2700 to 2900	75.5
Emitter 15	16.2	1.3	2865	41.4
Emitter 16	10.5	0.6	5625	41.4
Emitter 17	4.3	0.1	5500 to 5600	84.4
Emitter 18	14.9	1.5	5400 to 5700	56.2
Emitter 19	16.5	1.6	5400 to 5700	30.1
Emitter 20	15.5	1.6	5470 to 5600	54.0
Emitter 21	9.8	1.0	5600 to 5650	78.4
Emitter 22	6.5	6.5	1783.74	3.7
Emitter 23	0.2	0.2	2025 to 2110	22.3
Emitter 24	0.2	0.2	2025 to 2110	9.5
Emitter 25	0.4	0.4	2025 to 2110	9.5
Emitter 26	0.1	0.1	8250-8750	10.4
Emitter 27	0.2	0.2	2025 to 2120	12.9
Emitter 28	1.2	1.2	421 to 430	6.9
Emitter 29	5.0	0.1	9380-9440	9.3
Emitter 30	3.3	0.1	3040-3060	9.3
Emitter 31	5.0	0.2	9410 ± 21.5	8.5
Emitter 32	0.0	0.0	17100 to 17300	10.4
Emitter 33	81.2	3.2	5650 to 5850	27.9
Emitter 34	118.2	7.5	5400 to 5900	39.1
Emitter 35	1.1	1.1	10490	39.1
Emitter 36	8.1	8.1	10499	5.4
Emitter 37	0.7	0.0	9380 to 9440	17.8
Emitter 38	0.1	0.1	1763.721 - 1839.795	4.1
Emitter 39	0.1	0.1	5690	4.1
Emitter 40	0.6	0.0	9380 to 9440	16.3

4.1.3.2 Lightning

Blue Origin's PPF, manufacturing facilities, and the launch pad at LC-36 feature lightning protection systems. The PPF and manufacturing facilities incorporate rooftop lightning rods and grounded lightning protection cables. The LC-36 lightning protection system includes multiple fixed towers supporting catenary wires arranged to intercept cloud-to-ground lightning and prevent direct strikes to the launch vehicle or payload. The Cape Aural Warning System further provides warning of lightning strike risk with enough lead time to safe all necessary equipment in each location.

For more information on induced electric fields due to lightning strikes, please contact Blue Origin.

4.1.3.3 Electrostatic Fields

The New Glenn PLF is designed to prevent electrostatic discharge to any part of a payload's surface, provided the payload remains within the PLF dynamic envelope, defined in Section 5.2: Fairing. The maximum broadband electric fields 1 cm (0.394 in) from the PLF inner surface are limited to the levels in Table 4-4 and Figure 4-2 below.

Table 4-4: PLF broadband electrostatic field limits

Frequency (MHz)	E-field (dB μ V/m/MHz)
0.01	163
0.05	147
0.1	135
0.5	93
1.0	84
5.0	70
10.0	64
50.0	50
100.0	43
500.0	7
1000.0	-3

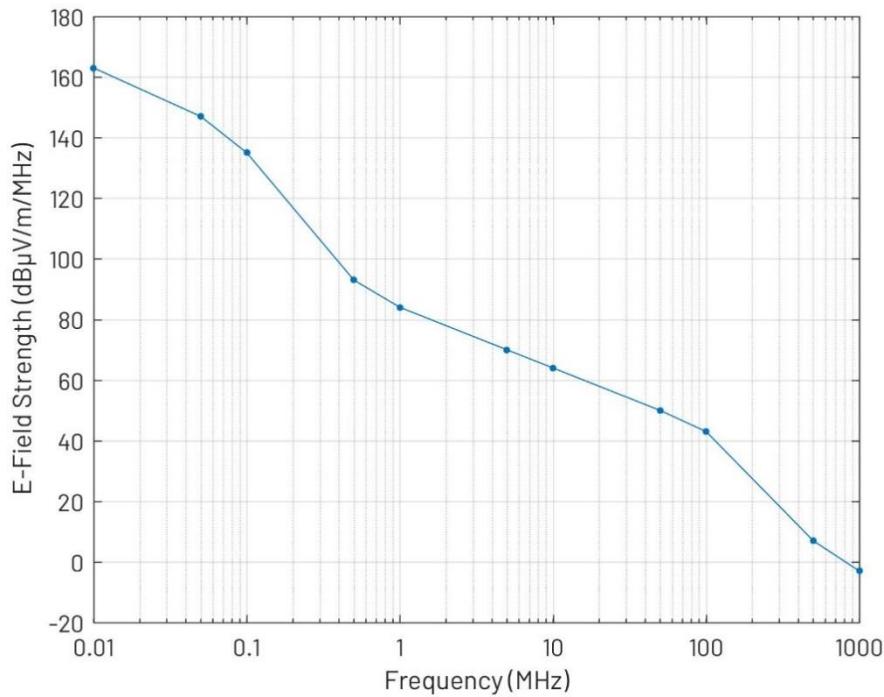


Figure 4-2: PLF broadband electrostatic field limits

4.1.3.4 Electromagnetic Interference Safety Margin

The New Glenn system is designed to mask or attenuate RF sources as required to maintain an electromagnetic interference safety margin (EMISM) of at least 20 dB for launch vehicle ordnance circuits and at least 6 dB for other non-ordnance sensitive launch vehicle circuits.

4.1.4 Contamination Control, Ground

During the pre-launch period, the customer has access to the Blue Origin partner's PPF facilities as part of standard launch services. These facilities provide Class 100,000 (ISO Class 8) processing bays and encapsulation bays, using high efficiency particulate air (HEPA) filters with 4-6 air changes per hour. As part of optional launch services, Class 10,000 (ISO Class 7) cleanliness is available on as-needed basis through stricter filtration, customer operations, and garment protocols. The PPF also limits organic contamination exceeding 0.5 mg/m²/week (0.046 mg/ft²/week) prior to encapsulation. For more information on PPF capabilities, see Section 8.1.2: Payload Processing Facility.

Following encapsulation, the operations teams maintain supply air cleanliness to the encapsulated payload volume to Class 5,000 (ISO Class 6.7) standards during all pre-launch operations, including during transportation from PPF to the IF, within the IF for integration with the launch vehicle, during rollout, and at the launch pad.

The PLF is manufactured and cleaned to maintain Nonvolatile Residue (NVR) before encapsulation in the PPF to less than 1 mg / 0.1 m² (1 mg/ft²). Particulate contamination of surfaces in the vicinity of the payload are maintained below the limits described in Table 4-5.

Table 4-5: Particulate cleanliness near the payload

Particle Size µm (inches)	Particle Count per 0.1 m ² (ft ²)
50(0.002)	12,800(11,800)
100(0.004)	1,190(1,090)
250(0.01)	28.1(26.3)
500(0.02)	1.08(1)
750(0.03)	0(0)

Blue Origin provides additional support equipment to maintain the cleanliness specified herein when accessing the encapsulated payload. All Blue Origin ground support equipment (GSE) used within the PLF will be cleaned to the same standards before use.

4.2 LAUNCH AND FLIGHT ENVIRONMENTS

4.2.1 Acceleration Loads, Flight

During a nominal flight profile, payloads experience axial and lateral acceleration resulting from winds, liftoff, ascent max aerodynamic flight events, maximum axial G forces, second stage ignition, steady burn, and shutdown. Conservative limits to loads are shown in Figure 4-3 below for use in initial design of payload structural elements. Positive axial acceleration values indicate compression, whereas negative axial acceleration values indicate tension. BE-4 and BE-3U engine throttling capability enables New Glenn to maintain accelerations within these limits:

- o X-axis (axial) loads on the payload to between -2 g and 6 g.
- o Y,Z-axis (lateral) loads on the payload to less than 2 g, to less than 0.6 g when axial loads are below -1 g, and to less than 0.5 g when axial loads are over 3.3 g.

At present, no distinction is made between design load factors based on payload mass. For either light payloads (less than 3,000 kg or 6,600 lbm) or heavy payloads (more than 8,000 kg or 17,600 lbm), customers should rely on a coupled loads analysis (CLA) for more accurate characterization of the mechanical environment. The CLA of the payload conducted during the mission integration phase will produce specific predictions for structural load factors, bending moments and accelerations as inputs to the customer's design processes.

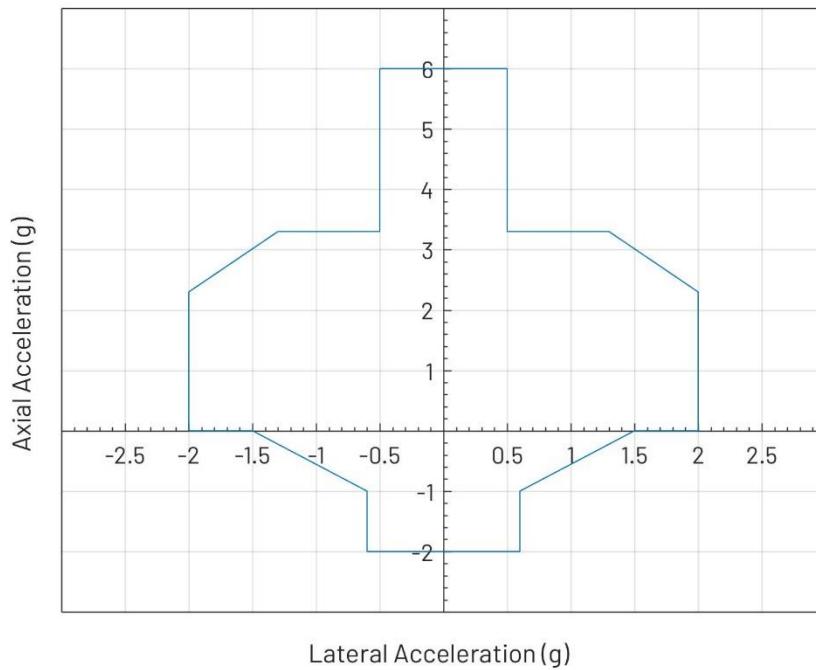


Figure 4-3: Design limit loads

4.2.2 Thermal, Flight

The PLF thermal protection system is insulation designed to minimize the heat load imparted to the fairing structure and the payload. The PLF inner wall peak radiated (encapsulated) heat flux density is predicted to be less than $1,000 \text{ W/m}^2$ ($317 \text{ BTU/ft}^2 \text{ hr}$). Heat flux density as low as 600 W/m^2 ($190 \text{ BTU/ft}^2 \text{ hr}$) may be possible as part of optional launch services; please contact Blue Origin for more information.

Standard timing of the fairing separation allows 3-sigma maximum free molecular (un-encapsulated) heat flux density on the payload to be no greater than $1,009 \text{ W/m}^2$ ($320 \text{ BTU/ft}^2 \text{ hr}$). The total absorbed energy during ascent is less than or equal to the maximum total integrated energy indicated by the temperature profile shown in Figure 4-4.

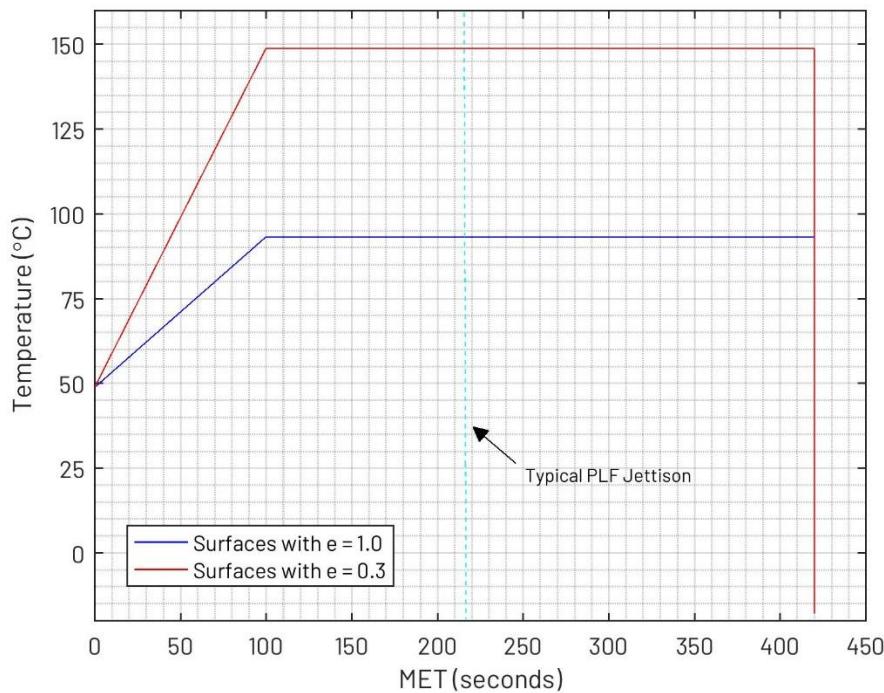


Figure 4-4: Maximum PLF inner surface temperatures

4.2.3 Electromagnetic, Flight

The launch system generates a variety of EM fields both before and during flight, which may cause potential interference with sensitive payload elements or materials. Blue Origin performs a launch vehicle electromagnetic compatibility assessment based on the payload's radiated emissions and New Glenn susceptibility as part of standard launch services. The customer is encouraged to perform their own compatibility testing to ensure operability within the following radiated environments.

The New Glenn launch system limits its spurious and intentional EM emissions at the AIP (free space radiating conditions), as per Section 5.2.1: Payload Volume, to the levels shown in Table 4-6 and Figure 4-5 below.

Table 4-6: New Glenn allowable radiated emissions / payload RF susceptibility

Frequency Range (MHz)	E-field Limit (dB μ V/m)	Source
All Emissions	100	
400 – 470		
2200 – 2300	145	New Glenn communications

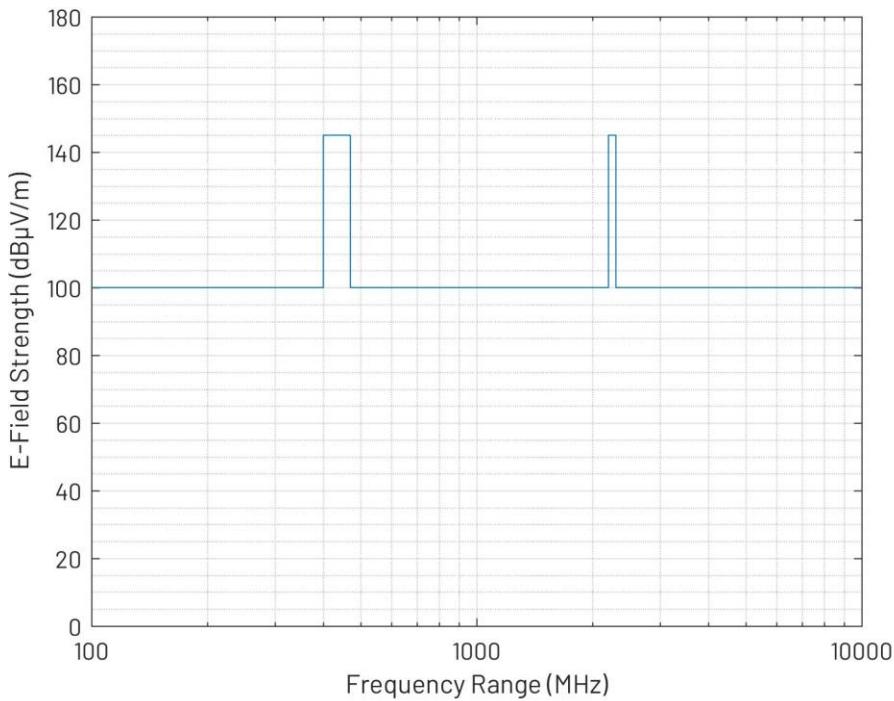


Figure 4-5: New Glenn allowable radiated emissions / payload RF susceptibility

In a dual manifest mission, it will also be necessary for each payload to establish RF compatibility with one another. One method to minimize risk is to permit payload RF susceptibility greater or equal to 160 dB μ V/m at frequencies greater than 1,000 MHz, apart from the payload receiver frequency bands.

4.2.4 Contamination Control, Flight

Blue Origin has selected specific non-metallic materials to minimize outgassing of New Glenn's payload accommodations to satisfy these requirements when exposed to thermal vacuum:

- Less than 1% total mass loss (TML)
- Less than 0.1% collected volatile condensable material (CVCM)

Similarly, the payload itself is limited to the same targets for TML and CVCM (see Section 3.5: Material Selection for Contamination Control). Contamination levels are verified by analysis according to *ASTM E595-15 Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment*.

Between encapsulation at the PPF and payload separation for most missions, the New Glenn system limits particulate contamination of the payload such that it obscures less than 1% of payload surfaces and minimizes molecular contamination of the payload to deposition of less than 150 angstroms.

4.2.5 Acoustics

The PLF uses several acoustic protection systems to reduce internal noise to an acceptable level during launch, and may be configurable depending on specific payload requirements. The acoustic pressure space-averaged over the volume inside the fairing has been baselined to envelope the acoustic requirements of most spacecraft manufacturers. Acoustic pressure is not to exceed the levels given in Table 4-7 and Figure 4-6 with 95% probability with 50% confidence (P95/50) for a 60% payload fill factor from liftoff through payload separation. For more information on lower frequency sound pressure levels, please contact Blue Origin.

Table 4-7: PLF sound pressure level

Center Frequency (Hz)	1/3 Octave Band Pressure (dB WRT μPa)	Full Octave Band Pressure (dB WRT μPa)
100	130	-
125	131	135.5
160	131	-
200	131	-
250	130	134.6
315	128	-
400	126	-
500	124	129.1
630	122	-
800	119.5	-
1,000	117.8	122.9
1,250	116.4	-
1,600	114.5	-
2,000	112.5	117.7
2,500	111	-
3,150	109	-
4,000	108	112.8
5,000	107	-
6,300	106	-
8,000	104	109.1
10,000	102	-
OASPL	139.9	139.9

Note: Assumes 60% fill factor

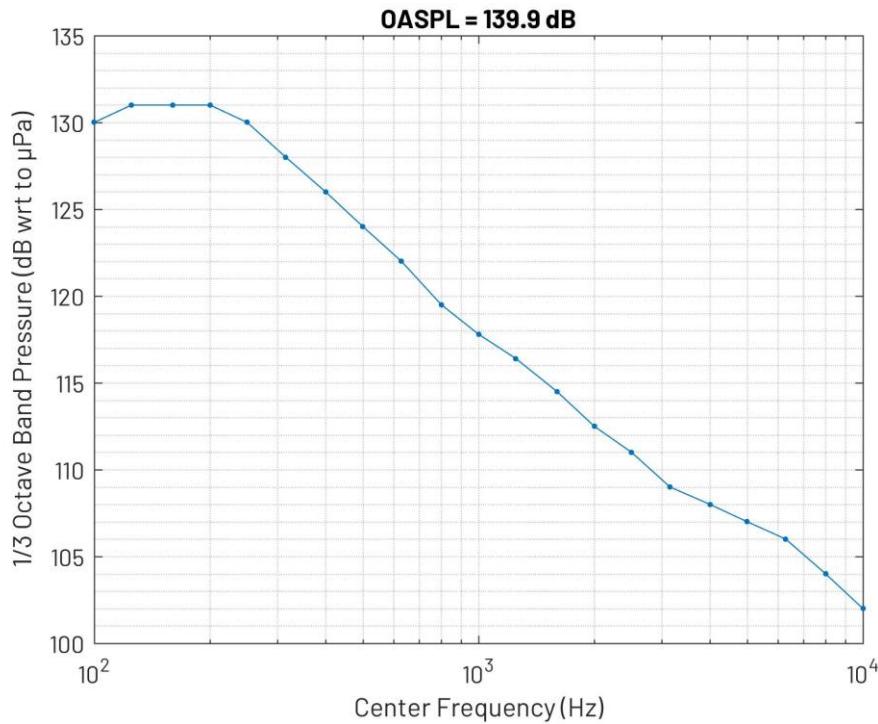


Figure 4-6: PLF sound pressure level

4.2.6 Vibration

Low to mid-frequency sine vibration is highest in response to discrete events such as liftoff, wind gusts, main engine cut-off (MECO), PLF jettison, and second stage engine start and cut off. Maximum predicted lateral and axial sinusoidal vibration at the interface with the payload adapter throughout all flight phases is shown in Table 4-8 and Figure 4-7. Mission-specific vibration levels are confirmed by CLA after receipt of the payload's exact structural and mass properties.

Table 4-8: Lateral and axial sinusoidal vibration

Frequency Range (Hz)	Lateral Acceleration (g)	Axial Acceleration (g)
2 - 25	0.8	1
25 - 50	0.6	1
50 - 100	0.6	0.8

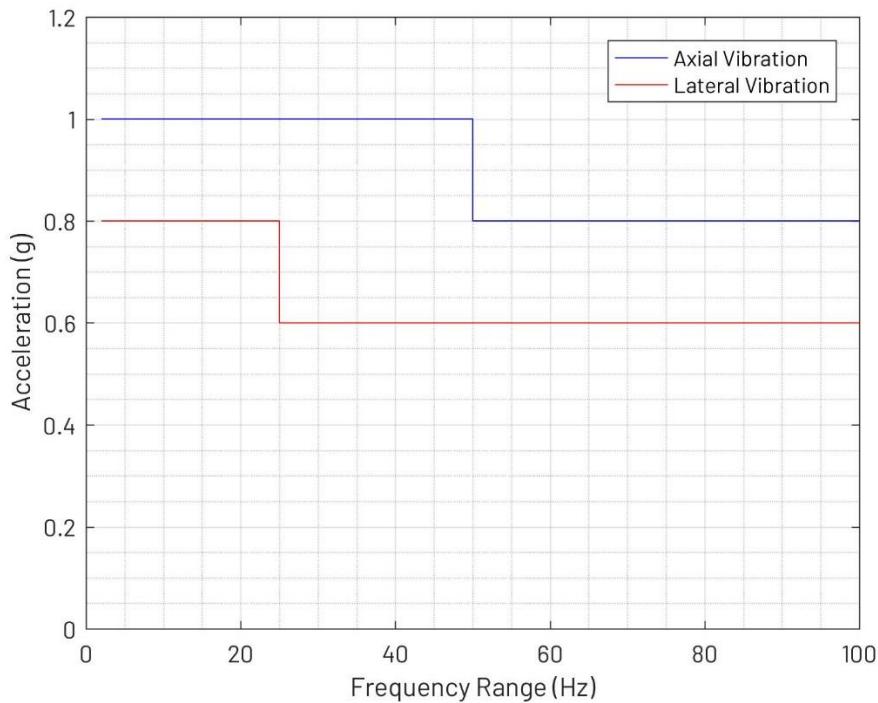


Figure 4-7: Lateral and axial sinusoidal vibration

4.2.7 LV to Payload Shock

Shock loads are mainly caused by three (3) significant events: second stage separation, PLF jettison, and payload separation. The shock from payload separation, which is largely determined by the mission-unique payload adapter system (PAS) chosen for separation, envelopes all shock from PLF jettison and stage separation.

Given the range of PAS that are available as a standard launch service, described in Section 5.3.2: Payload Adapter System, the launch vehicle-induced payload shock at the AIP interface with the PAS is limited to the P95/50 accelerations shown in Table 4-9 and Figure 4-8 and measured within 51 mm (2 in) of the AIP.

Table 4-9: Payload shock induced by the launch vehicle

Frequency (Hz)	Shock Response (G-Peak)
100	20
1000	1000
10000	1000

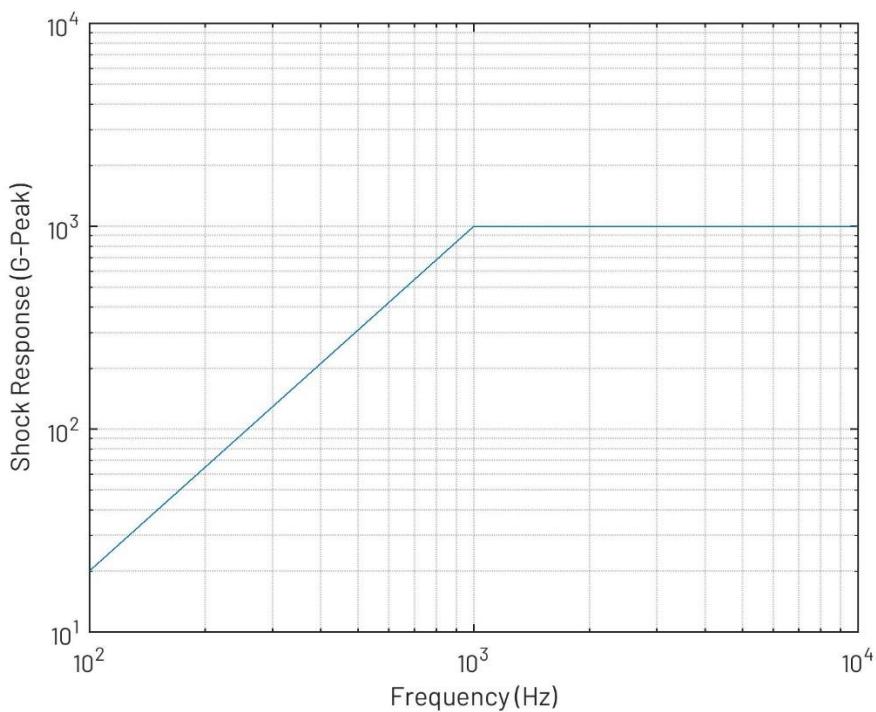


Figure 4-8: Payload shock induced by the launch vehicle

4.2.8 Static Pressure

The PLF incorporates a series of vents to help control the pressure decay during ascent. These covered vents help maintain cleanliness within the payload volume during ground operations and boost, while providing a peak depressurization rate of less than 4,100 Pa/s (0.60 psi/s). Except for short periods including immediately following separation of the vent covers and the transonic flight regime, steady-state depressurization rates are limited to 2,400 Pa/s (0.35 psi/s). The encapsulated payload volume maintains a differential pressure of less than 400 Pa (0.06 psi) above ambient external at the time of fairing jettison. Please contact Blue Origin for more information on venting analysis.

5.0 INTERFACES

5.0 INTERFACES

This section details the payload accommodations in terms of mechanical and electrical interfaces available to the payload and its ground support equipment (GSE), including the payload fairing (PLF), the fixed adapter, and the payload adapter system (PAS).

5.1 VEHICLE AXES DEFINITION

The New Glenn system uses an X-Y-Z reference axis system, with the axial origin located below the base of the first stage center engine. The X(roll) axis is aligned with the centerline of the vehicle, the Y(pitch) axis is aligned with the plane of the aft strakes, and the Z(yaw) axis is normal to the rocket-facing plane of the transporter erector (TE), completing the right-handed coordinate system. This coordinate system is illustrated in Figure 5-1 below.

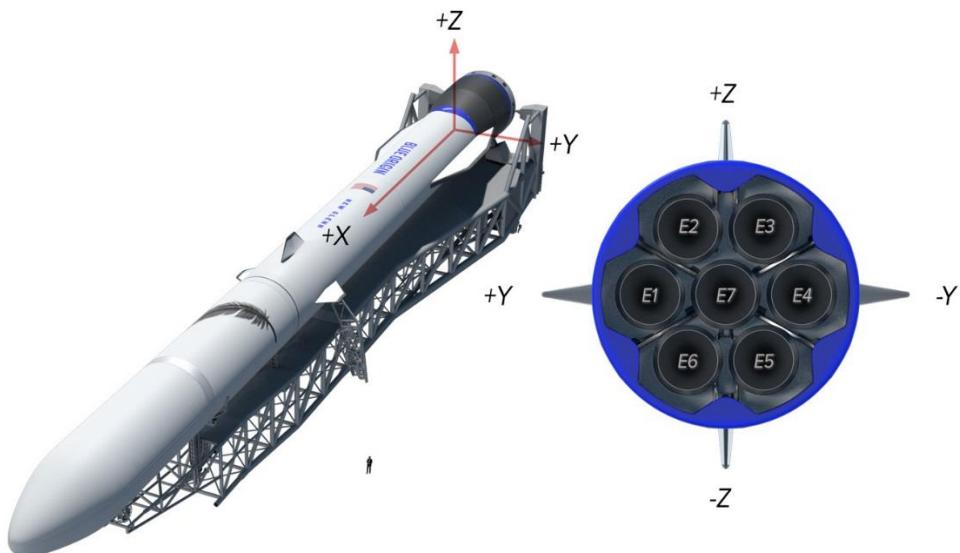


Figure 5-1: New Glenn reference axes and coordinate system

5.2 FAIRING

New Glenn's standard offering PLF measures 7 m (23 ft) in diameter and 21.9 m (72 ft) tall. The bi-sector assembly consists of two (2) monolithic half shell composite sandwich panels manufactured in-house. The PLF halves are joined laterally by a thrusting rail assembly, and at the aft end by a circumferential frangible joint, which together provide rapid, debris-free separation of the halves from each other, the fixed adapter, and the second stage. The PLF halves jettison shortly after second engine ignition on the second stage, and they are designed to thrust away to preclude contact with both the second stage and the payload by more than the required 25.4 mm (1 in) clearance.

The PLF is designed to protect the payload from the dynamic thermal, acoustic, and pressure conditions of launch while maintaining high levels of environmental control and cleanliness during pre-launch activities. The 7-meter baseline fairing has an internal usable volume of at least 450 m^3 (16,000 ft 3) – sufficiently large for dual manifesting of two full-size spacecraft or for multi-manifesting constellation deployments. The additional diameter and height enable payloads with larger aperture reflectors and optics, more transponders, and simpler deployment mechanisms for solar panels and antennas than with a 5-meter class PLF. Please contact Blue Origin for more information about how to make best use of the 7-meter PLF.

5.2.1 Payload Volume, Single Manifest

The payload usable volume and mass capacity differ depending on which of the fixed adapter configurations is chosen: standard capacity, intended for most single spacecraft missions, and high capacity, intended for larger single payloads and/or multi-spacecraft dispenser missions.

Blue Origin defines the payload usable volume as the dynamic envelope within which the spacecraft may move and internally deflect without impingement by the PLF. The dynamic envelope takes into account PLF deflection, fixed adapter deflection, manufacturing tolerances, and a 25.4 mm(1 in) dynamic clearance.

5.2.1.1 Standard Capacity, Standard Volume

The standard capacity configuration accommodates a payload and PAS that remain within the dynamic envelope described in Figure 5-2, and with a mass as per Section 3.1: Mass Properties. The standard capacity standard dynamic envelope combines the following volumes about the longitudinal (X) axis of the launch vehicle:

- A cylindrical volume with a diameter of between 6,228.1 and 6,350 mm (245.2 and 250 in) and height of 10,520.7 mm (414.2 in) beginning 203.2 mm(8 in) above the adapter interface plane (AIP), and;
- An ogive volume that extends another 7,112 mm (280 in) above, and;
- A smaller cylindrical volume with a diameter of 1,625.6 mm (64 in) and extending 203 mm (8 in) between the bottom of the larger cylindrical volume and the AIP.

The standard capacity standard volume shares an axis of symmetry through the center of the AIP, and is a maximum of 17,835.9 mm (702.2 in) tall. The associated optional volume, as described next in Section 5.2.1.2: Standard Capacity, Optional Volume, is located directly beneath the standard volume.

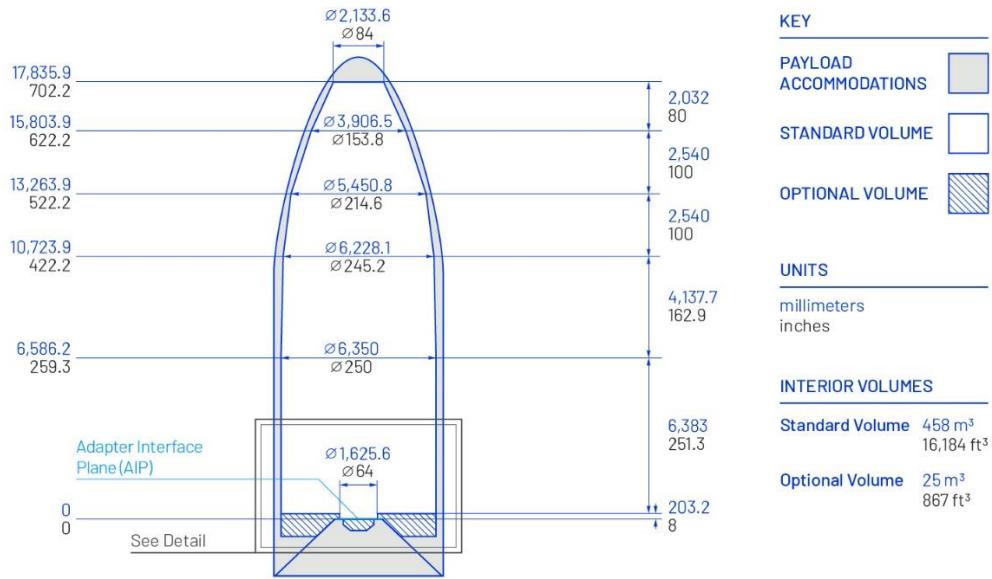


Figure 5-2: Standard capacity standard payload volume

5.2.1.2 Standard Capacity, Optional Volume

In standard capacity configuration, the payload may use the volume around and below the AIP both inside and outside of the fixed adapter and PAS on a mission-unique basis, pending a dynamic clearance and coupled loads analysis. The optional volume, detailed in Figure 5-3 permits antennas, nozzles, or other spacecraft components to hang below the AIP while avoiding the PLF vents at the base of the fixed adapter. Inside the fixed adapter, a curved composite barrier closes out and separates the volume below the AIP from the forward tank dome of the upper stage. Please contact Blue Origin to determine if use of the optional volume will meet the payload's requirements.

The standard capacity optional volume shares an axis of symmetry through the center of the AIP, and extends a maximum of 706.1 mm (27.8 in) below the AIP.

Detail

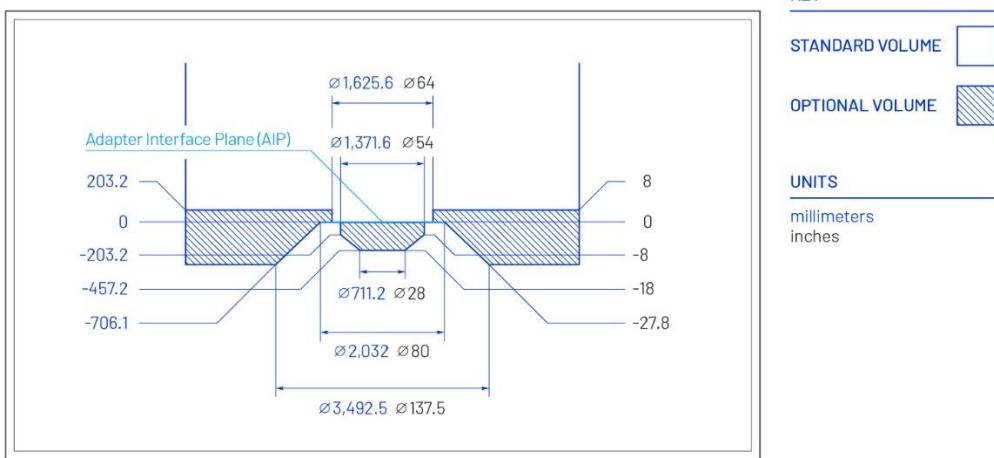


Figure 5-3: Detail of standard capacity optional volume

5.2.1.3 High Capacity, Standard Volume

The high capacity configuration accommodates a payload and adapter or dispenser that remain within the dynamic envelope described in Figure 5-4, and with a mass as per Section 3.1: Mass Properties. The high capacity standard dynamic envelope combines the following volumes about the longitudinal(X)axis of the launch vehicle:

- A cylindrical volume with a diameter of between 6,228.1 and 6,350 mm (245.2 and 250 in) and height of 11,430 mm (450 in) beginning at the AIP, and;
- An ovoid volume that extends another 7,112 mm (280 in) above.

The high capacity standard volume shares an axis of symmetry through the center of the AIP, and is a maximum of 18,542 mm (730 in) tall.

In high capacity configuration, there is no additional optional volume available. Due to the larger interface diameter on a shared fixed adapter cone design, the high capacity AIP sits 706.1 mm (27.8 in) below the AIP of the standard capacity configuration – in effect already using all of the standard capacity optional volume. A high capacity payload cannot use any volume below the AIP, due to the location of fairing vents as well as a composite barrier that closes out and separates the payload volume from the forward tank dome of the upper stage.

This design assumes that most high capacity payloads will either use a raising cylinder or adapter, such as the COTS PAS designed for use on the high capacity interface (see Section 5.3: Mechanical Adapters and Separation Systems), or require their own mission-unique separation system or dispenser post that already accommodates their specific geometries.

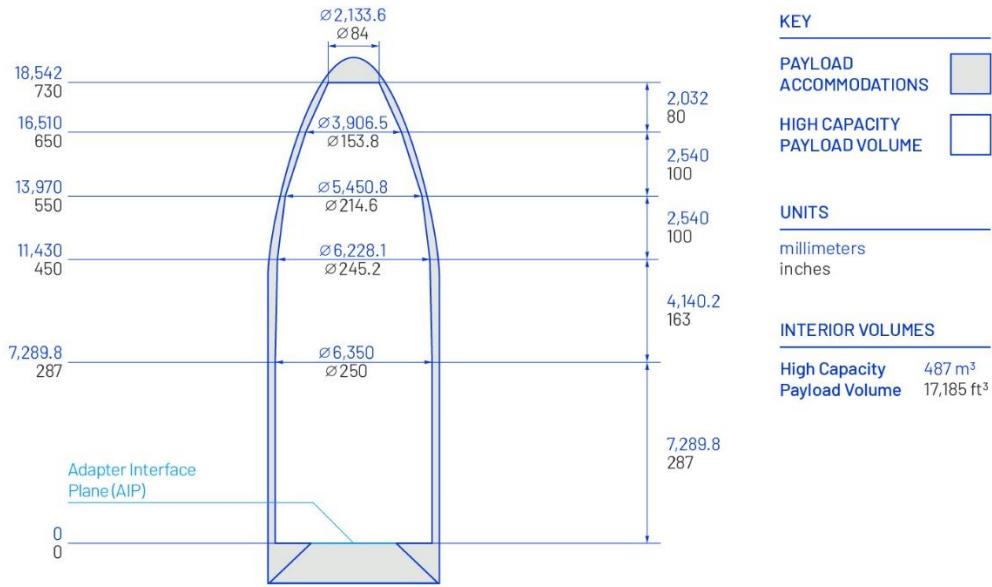


Figure 5-4: High capacity standard volume

5.2.2 Payload Volume, Dual Manifest

The payload usable volume and mass capacity of the dual manifest upper and lower berths are identical and are designed to be completely interchangeable as a standard launch service. This approach facilitates pairing spacecraft of nearly any size and mass without constraint beyond the overall performance of New Glenn. Each berth uses the same standard capacity fixed adapter configuration and is compatible with the same range of COTS PAS.

Blue Origin defines the payload usable volume as the dynamic envelope within which the spacecraft may move and internally deflect without impingement by either the PLF or the dual manifest structure. The dynamic envelope takes into account PLF and dual manifest structure deflection, fixed adapter deflection, manufacturing tolerances, and a 25.4 mm (1 in) dynamic clearance.

5.2.2.1 Dual Manifest, Standard Volume

The dual manifest configuration accommodates a payload and PAS that remain within the dynamic envelope described in Figure 5-5, and with a standard capacity mass as per Section 3.1: Mass Properties. The dual manifest standard dynamic envelope combines the following volumes about the longitudinal (X) axis of the launch vehicle:

- A cylindrical volume with a diameter of 5,773.4 mm (227.3 in) and height of 3,665.2 mm (144.3 in) beginning 203.2 mm (8 in) above the adapter interface plane (AIP), and;
- An ogive volume that extends another 3,523 mm (138.7 in) above, and;

- A smaller cylindrical volume with a diameter of 1,625.6 mm (64 in) and extending 203 mm (8 in) between the bottom of the larger cylindrical volume and the AIP.

The dual manifest standard volume shares an axis of symmetry through the center of the AIP, and is a maximum of 7,391.4 mm (291 in) tall. The associated optional volume, as described next in Section 5.2.2.2: Dual Manifest, Optional Volume, is located directly beneath the standard volume.

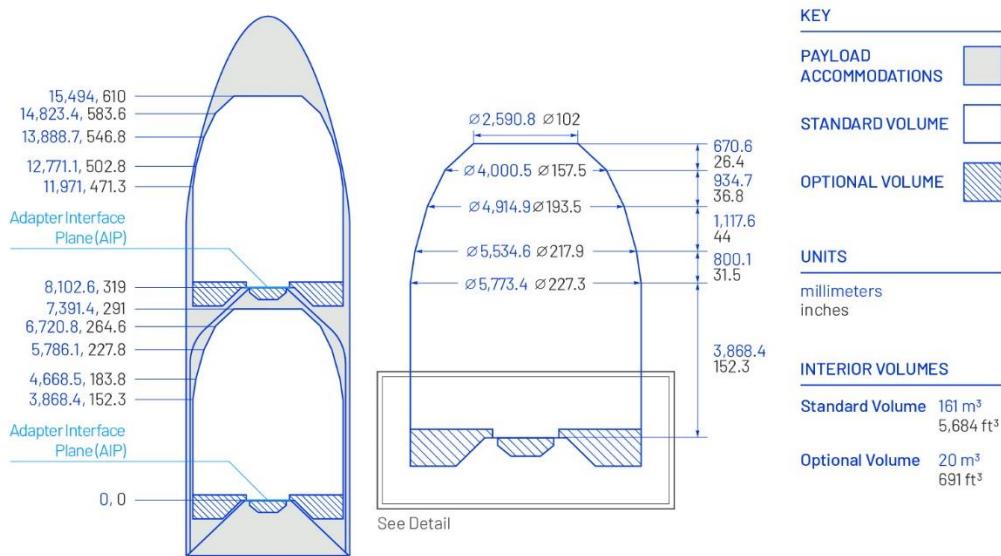


Figure 5-5: Dual manifest standard volume

5.2.2.2 Dual Manifest, Optional Volume

In dual manifest configuration, the payload may use the volume around and below the AIP both inside and outside of the fixed adapter and PAS on a mission-unique basis, pending a dynamic clearance and coupled loads analysis. The optional volume, detailed in Figure 5-6 permits antennas, nozzles, or other spacecraft components to hang below the AIP while avoiding the PLF vents at the base of the dual manifest structure. Inside the lower berth fixed adapter, a curved composite barrier closes out and separates the volume below the AIP from the forward tank dome of the upper stage. Please contact Blue Origin to determine if use of the optional volume will meet the payload's requirements.

The dual manifest optional volume shares an axis of symmetry through the center of the AIP, and extends a maximum of 706.1 mm (27.8 in) below the AIP.

Detail

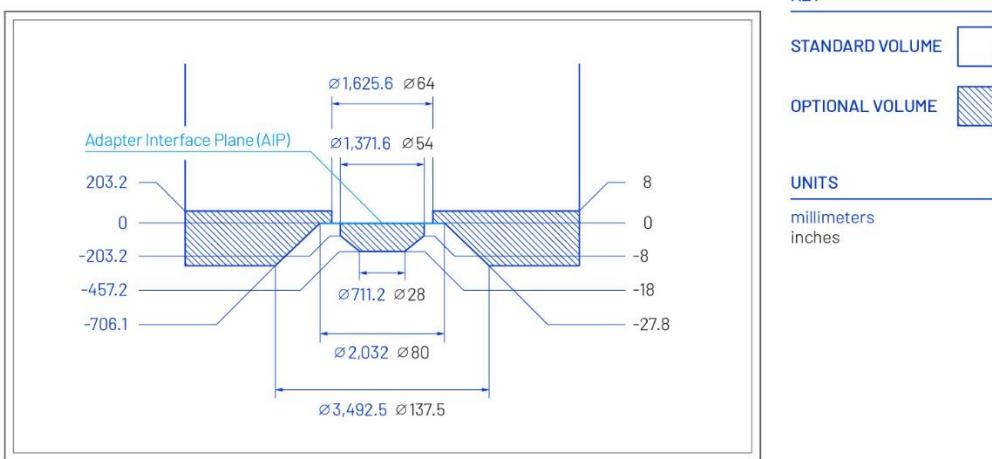


Figure 5-6: Detail of dual manifest optional volume

In the upper berth only, additional volume exists below the AIP and in the ogive section of the PLF. These maximum volumes are available as part of optional launch services and are detailed in Appendix C: Dual Manifest, Maximum Volume.

5.2.3 Payload Volume, Multi Manifest and Rideshare

New Glenn is capable of accommodating both multiple manifest and rideshare/auxiliary spacecraft payloads. Interfaces and availability for these capabilities will be described in future revisions of the Payload User's Guide. Customers may contact Blue Origin for more information on multiple manifest and rideshare/auxiliary opportunities.

5.2.4 Accessibility

The PLF is designed to accommodate up to two (2) access doors or radio frequency (RF) windows in any combination, while still maintaining all specified environmental conditions, structural integrity, and lightning protection. Dual manifest mission PLFs may have up to four (4) doors and windows in any combination.

The area acceptable for access doors and RF windows is defined by a 120 degree arc centered about the Z axis, with 30 degree gaps/keep out zones on each side of the PLF split plane (Y axis). The placement zone is up to 10,160 mm (400 in) in length starting 1,828.8 mm (72 in) above the base of the PLF and up to 7,340.6 mm (289 in) wide in arc length and 6,070.6 mm (239 in) wide in plan view per PLF half, as shown by the shaded area in Figure 5-7.

On the bottom (-Z) PLF half, an additional keep out zone exists due to the attachment point of the environmental control system (ECS) umbilical.

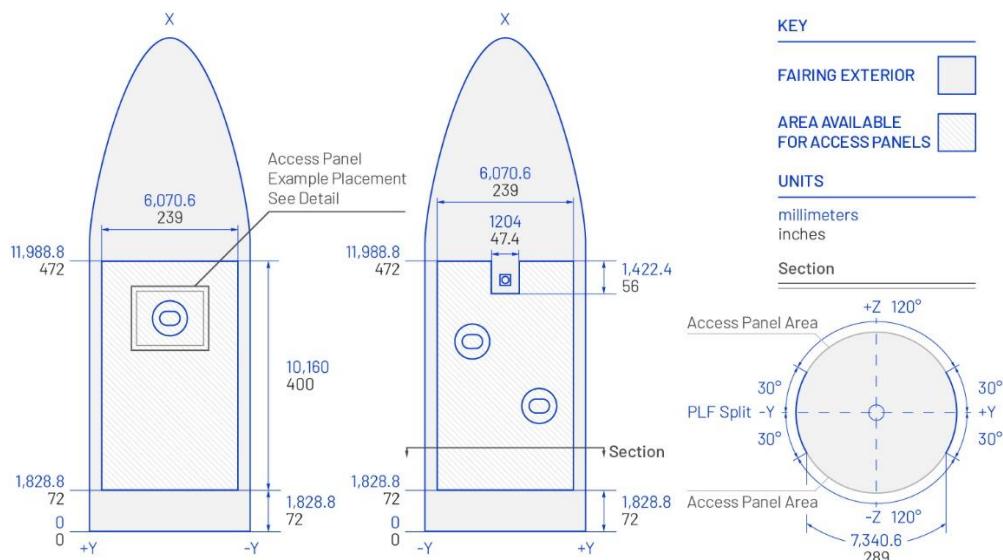


Figure 5-7: Access door and RF window placement areas

Access doors and RF windows may be up to 609.6 x 914.4 mm (24 x 36 in) as part of standard launch services. Both access doors and RF windows are manufactured of fiberglass sandwich panel, and RF shielding can be applied to access doors as required. A typical access door or RF window is shown in Figure 5-8, and consists of the door/window panel, high-temperature seals, structural support frame, and various attachment hardware. The approach allows flexible placement and easy repeated access to the payload, while maintaining the PLF structural integrity and internal environments.

Detail

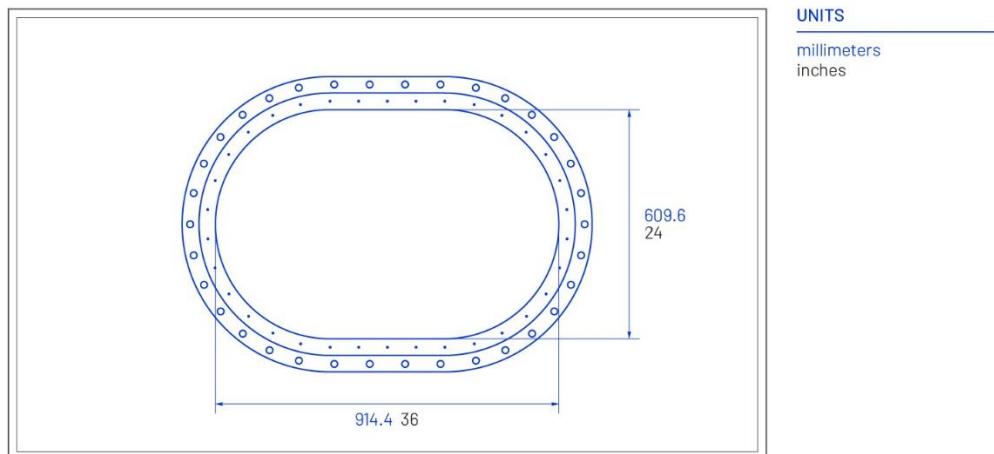


Figure 5-8: Standard access door or RF window arrangement

Larger doors or windows are available on a mission-unique basis. The placement of standard access doors and RF windows may be selected as late as 12 months

before the scheduled launch date, while mission-unique doors may require longer timeframes.

The payload may be accessed via any PLF access door as late as two (2) days before the scheduled launch as part of standard launch services, following the horizontal integration and mating of the encapsulated payload. Door placement and orientation on the PLF may affect accessibility while on the TE.

RF communication with the encapsulated payload on the launch pad via custom re-radiation system is possible as part of optional launch services. Note that between 90 minutes before launch through 20 seconds after payload separation, all payload RF communication must be within flight configuration levels, as per Section 3.4: Payload Radiated Emissions.

5.2.5 Branding and Logo

The PLF can support a corporate or mission-specific branding identity or logo as desired. As part of standard launch services, custom full-color external artwork can be applied to the artwork placement area as shown in Figure 5-9.

The artwork placement area is defined by a 120 degree arc centered about the Z axis, with 30 degree gaps/keep out zones on each side of the PLF split plane (Y axis). The placement zone is up to 10,363.2 mm (408 in) in length starting 1,524 mm (60 in) above the base of the PLF and up to 7,340.6 mm (289 in) wide in arc length and 6,070.6 mm (239 in) wide in plan view per PLF half.

Blue Origin works with the customer to ensure the best presentation of their logo on New Glenn. To ensure nominal schedule, artwork must be delivered electronically in high-resolution vector-based (such as encapsulated postscript, .EPS) file format no later than 3 months before the scheduled launch date.

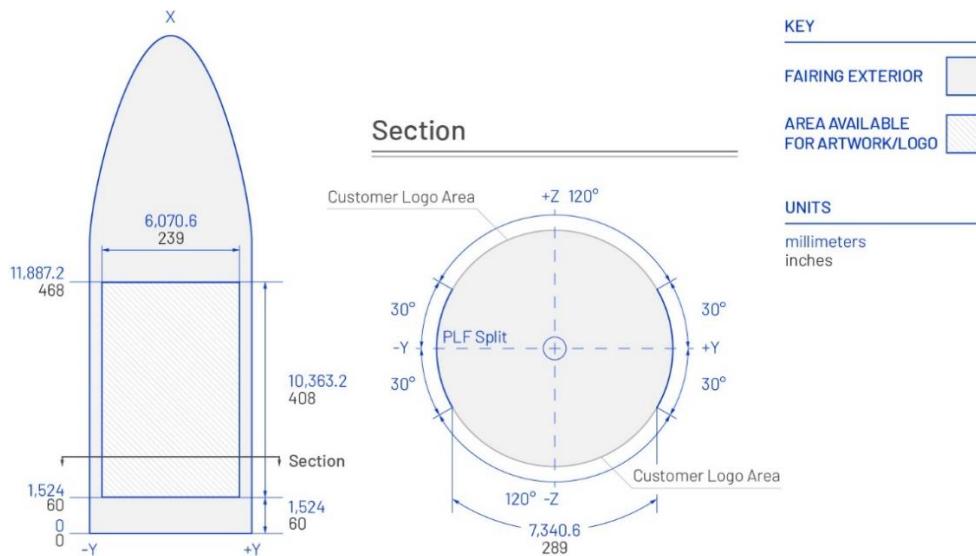


Figure 5-9: PLF artwork placement area

5.3 MECHANICAL ADAPTERS AND SEPARATION SYSTEMS

The fixed adapter provides the structural and electrical interface between the payload and the New Glenn launch vehicle. Once the launch vehicle achieves the specified orbital parameters, the second stage transmits a command to release the payload via one of many compatible high-reliability commercial off-the-shelf (COTS) separation systems, or mission-unique separation systems.

5.3.1 Fixed Adapter

In both standard and high capacity configurations, the fixed adapter consists of a single monolithic conical composite sandwich panel made in-house. The fixed adapter is designed to support the structural requirements of the mission as well as various mounted instruments, wire harnesses, access panels, frames, secondary structures and mounting brackets. The top of the fixed adapter is a machined aluminum ring that constitutes the AIP between the composite fixed adapter cone and the PAS or other separation system. The fixed adapter provides an electrical bonding path to the payload across the PAS with a resistance of 2.5 mΩ or less. The fixed adapter and PAS are shown in Figure 5-10.

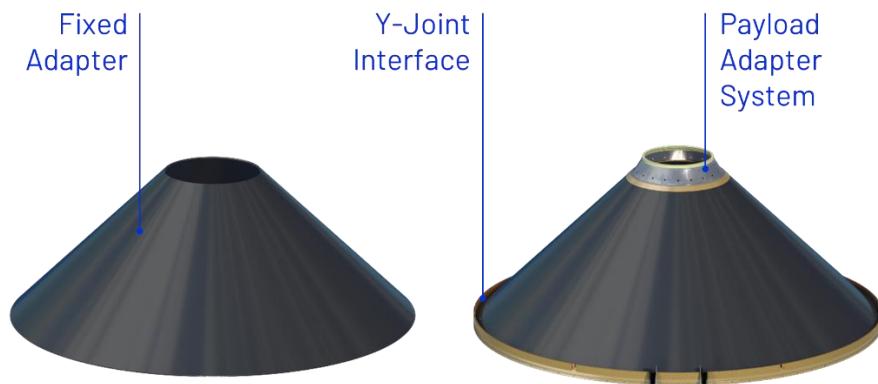


Figure 5-10: Standard capacity fixed adapter and payload adapter system

In the standard capacity configuration, the fixed adapter provides an Evolved Expendable Launch Vehicle (EELV) Standard Interface Specifications (SIS)-compliant 1,575 mm (62 in) bolt circle as shown in Figure 5-11. This design is compatible with a range of COTS PAS, including 937 mm (37 in), 1,194 mm (47 in), and 1,666 mm (66 in) clamp bands, and 1,663 mm (66 in) four (4) separation nut systems, described in Section 5.3.2: Payload Adapter System. The payload adapter provides an electrical bonding path to the payload with a resistance of 2.5 mΩ or less. The standard capacity fixed adapter provides full spacecraft and PAS clocking capability. The symmetrical circular 120 bolt pattern permits straightforward payload orientation adjustment in three (3) degree increments to meet both launch vehicle and customer-specific mission requirements. If a

non-COTS PAS or other mission-unique separation system is preferred, Blue Origin can integrate flight hardware provided by the customer as long as it conforms to the standard capacity launch vehicle interface.

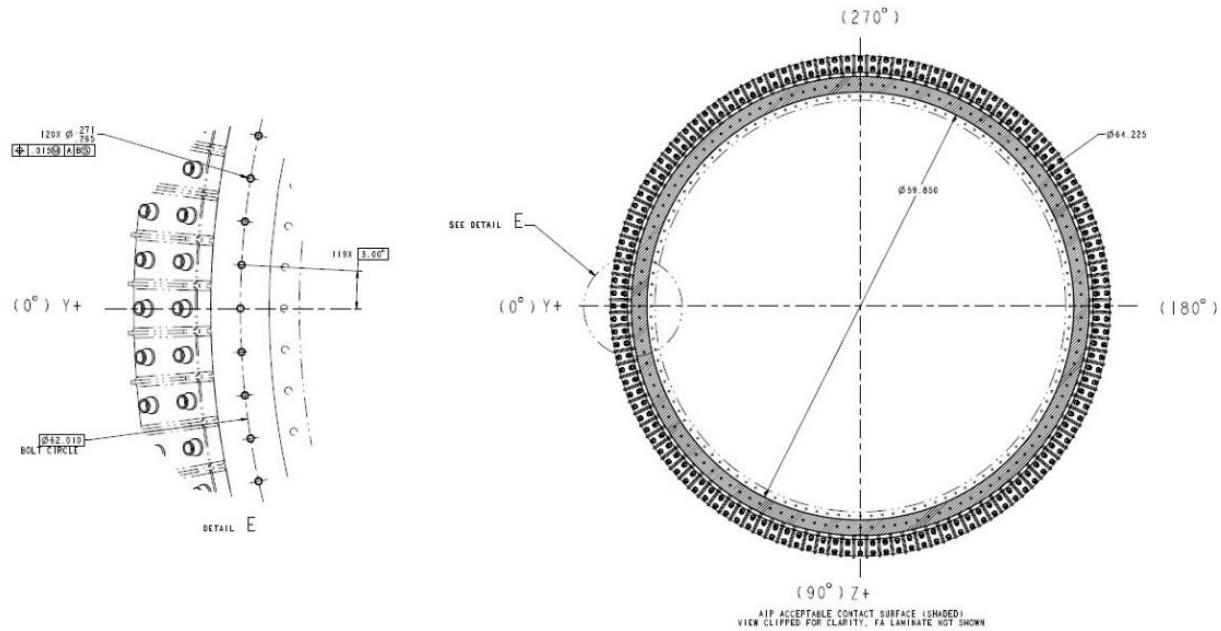


Figure 5-11: Standard capacity 1,575 mm (62 in) bolt circle interface

In the high capacity configuration, the fixed adapter provides a large diameter 3,169.9 mm (124.8 in) bolt circle designed to provide enhanced structural support for heavy spacecraft, payloads with high center of gravity, or multi-spacecraft dispenser structures. This design is compatible with a new COTS PAS currently under development by RUAG Sweden, the PAS 3100SX, which has a 3,075 mm (121.1 in) forward clamp band interface. As with the standard capacity configuration, the high capacity configuration offers full spacecraft or dispenser clocking capability. The symmetrical circular 120 bolt pattern, as shown in Figure 5-12, permits straightforward payload orientation adjustment in three (3) degree increments to customer-specific mission requirements. In the high capacity configuration, Blue Origin does not include the PAS 3100SX or any other separation system, but rather installs a customer-provided PAS or other separation system as part of the standard launch services. For more information about the high capacity configuration, please contact Blue Origin.

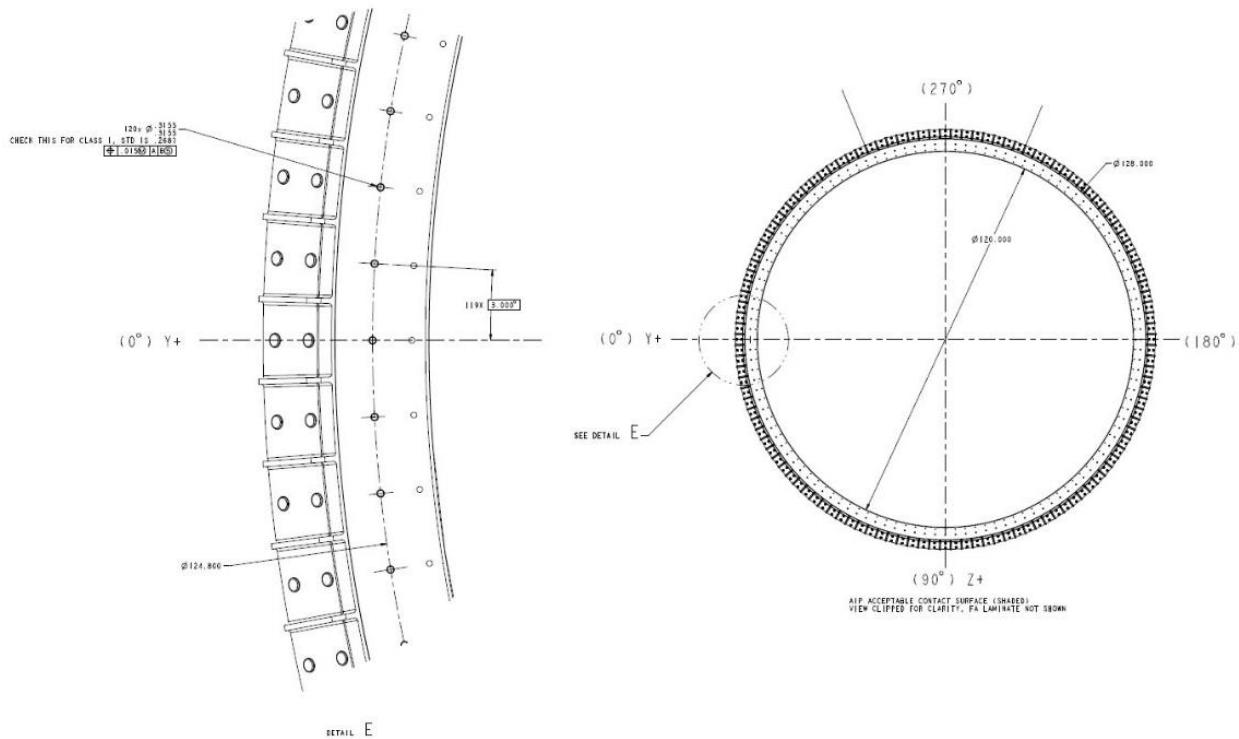


Figure 5-12: High capacity 3,170 mm (124.8 in) bolt circle interface

5.3.2 Payload Adapter System

For the standard capacity configuration, Blue Origin provides a COTS PAS for payload integration or otherwise assists in integration of the customer's mission-unique separation system as part of standard launch services. Blue Origin will supply common PAS options from either RUAG or Airbus, such as those listed in Table 5-1 below.

Table 5-1: Standard payload adapter system options

Model Number	Vendor	Height	Mass	Max Tension	CG Height for 5 MT
PAS 937S	RUAG Sweden	519 mm (20.4 in)	51 kg	40 kN	1.4 m
PAS 1194VS	RUAG Sweden	600 mm (23.6 in)	70 kg	60 kN	3.5 m
PAS 1666S	RUAG Sweden	330 mm (13 in)	52 kg	60 kN	5.7 m
PAS 3100SX	RUAG Sweden	TBD	TBD	TBD	TBD
LPSS 937	Airbus DS / CASA	380 mm (15 in)	55 kg	43 kN	2.3 m
LPSS 1194	Airbus DS / CASA	660 mm (26 in)	90 kg	56.5 kN	3.7 m
LPSS 1666	Airbus DS / CASA	500 mm (19.7 in)	70 kg	64 kN	5.9 m

PAS selection will be payload-dependent. The customer must provide notification of the desired PAS interface diameter no later than 14 months prior to the scheduled launch date due to procurement timelines.

The typical PAS includes a clamp band, clamp band opening device (CBOD) with pin puller or a low-shock payload separation system (LPSS), brackets, clamp band retention system, electrical harness with in-flight disconnect (IFD) umbilicals, and separation actuator set, shown in Figure 5-13.

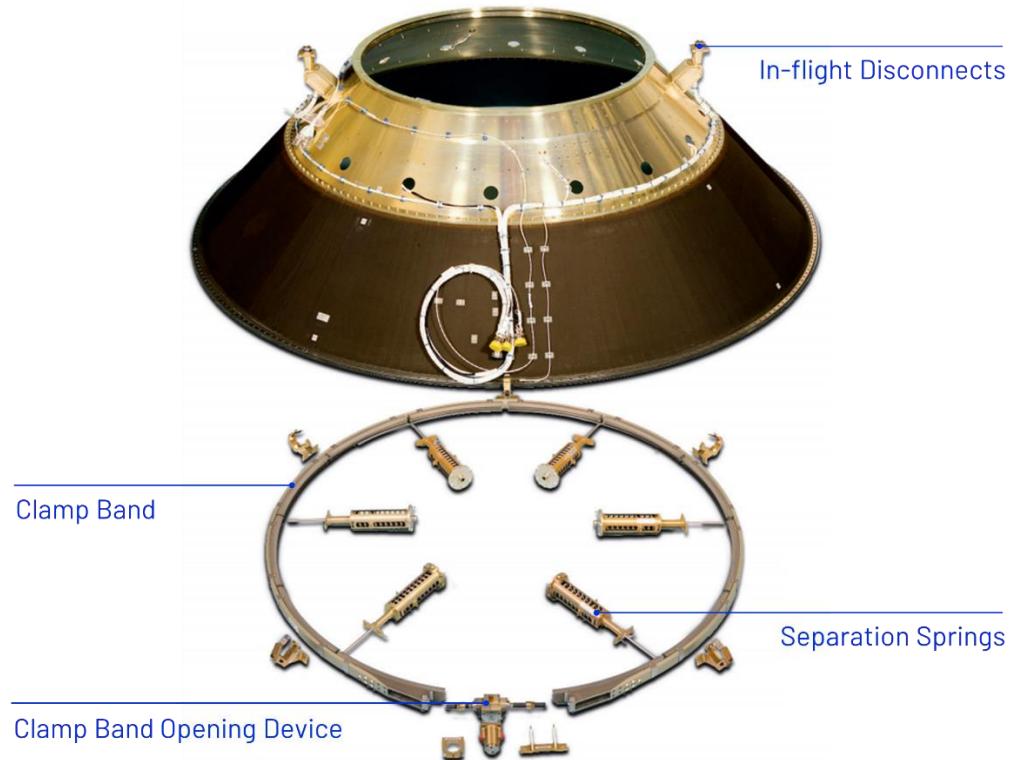


Figure 5-13: Example payload adapter system and clamp band elements

The clamp band releases after receiving redundant separation device commands from the launch vehicle avionics system. The system uses two (2) initiators equivalent to the NASA Standard Initiator (NSI) attached to the pin puller, with an all-fire current of 5.0 A required to initiate payload separation. The no-fire current is 1.0 A / 1.0 W for five (5) minutes and the ignition time of the system is 20 ms or less.

The number of separation springs varies between four (4) and 12, and is determined based on the payload separation velocity requirement, typically between 0.5-1.0 m/s(1.6-3.3 ft/s). Typical separation springs impart no more than 1500 N (337 lbf) per spring to the payload, and generate tip-off rates within the separation accuracy limits described in Section 2.7: Attitude Control. For more

information on PAS performance and availability, please contact Blue Origin.

5.4 DUAL MANIFEST STRUCTURE

The dual manifest structure is constructed in-house of composite sandwich panels similar to the PLF, including a forward adapter cone that shares heritage with the standard capacity fixed adapter. The composite structure interfaces with the upper stage by bolting to the same jointed interface as the lower, aft standard capacity fixed adapter and the PLF. Sidewalls of the structure also have integrated openings for environmental control systems, venting, RF communication, and access doors, as necessary. All main structural properties that affect payloads (e.g., mass capacity, moment / center of gravity, structural mode frequencies, mechanical interfaces) are consistent between upper and lower berths, as well as with standard capacity single manifest launch. The structure's preliminary shape and arrangement are shown in Figure 5-14.

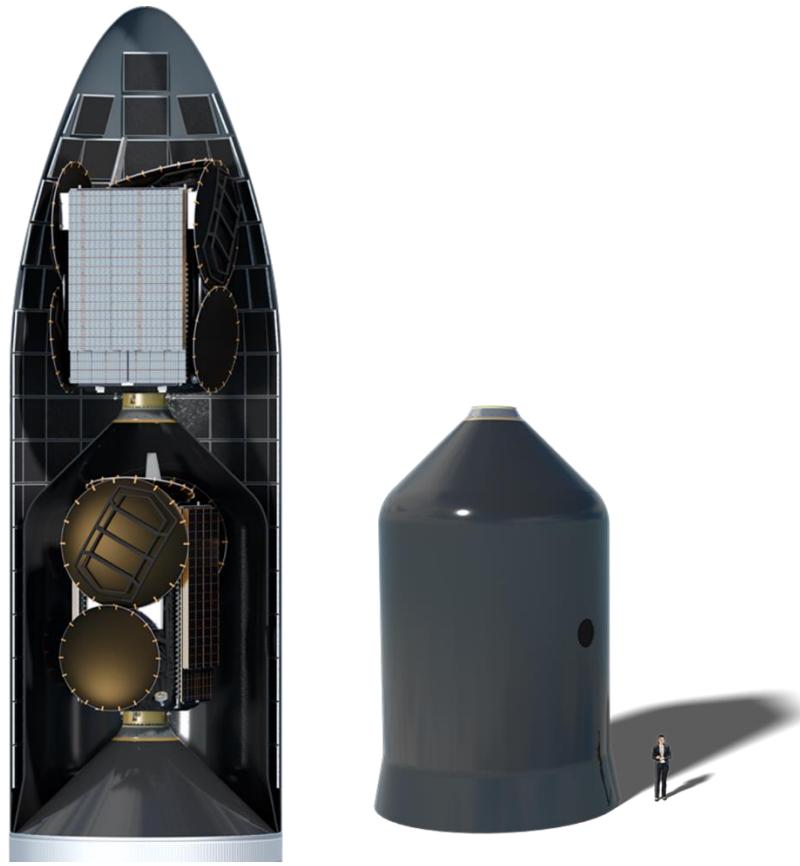


Figure 5-14: Concept design of the New Glenn dual manifest structure

The current barrel inner diameter is 6,324.6 mm (249 in) and the current height from aft launch vehicle interface to forward AIP interface is 10,600 mm (417.3 in) – sufficient to allow two tall, wide spacecraft to be encapsulated in the PLF at

once. The usable payload volume underneath and above the dual manifest structure is described in Section 5.2.2: Payload Volume, Dual Manifest.

Following upper berth payload separation, the upper stage reorients to jettison the dual manifest structure directly forward to reveal the lower berth payload, before reorienting again to separate the lower berth payload. Separation of the dual manifest structure is facilitated by a pyrotechnic frangible joint and distancing is achieved by a set of in-line separation spring modules. Jettison is subject to the same one (1) inch dynamic clearance requirement as the PLF to ensure there is no contact with the lower berth payload. For information on dual manifest performance and availability, see Section 2.5: Dual Manifest Capability.

5.5 ELECTRICAL

Pre-launch electrical connections are designed to meet commercial spacecraft manufacturer requirements. Depending on whether a payload uses 37-pin or 61-pin connectors, each payload can establish up to 122 data or electrical connections with the customer's supplied electrical ground support equipment (EGSE) via New Glenn's IFD umbilical system at the spacecraft interface plane (SCIP). The same IFD umbilical system is used to communicate separation and other signals between the launch vehicle avionics and the payload during flight. A representative diagram for data and electrical connections is shown in Figure 5-15 below. As part of optional launch services, additional cabling can be added per customer requirements.

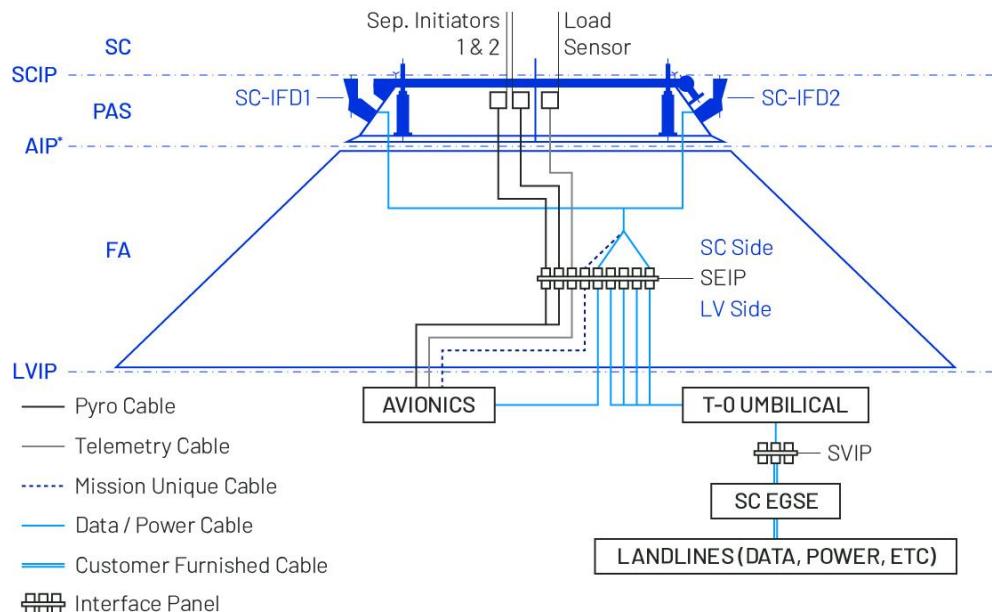


Figure 5-15: New Glenn electrical interfaces and wiring harness connections

5.5.1 Ground Support Equipment Electrical Interfaces

The customer has access to two (2) separate, identical EGSE rooms in the integration facility (IF) and launch pad for communication racks with direct umbilical connection to the payload during horizontal integration and after rollout to the pad. For dual manifest missions, each payload customer has their own EGSE room in both locations.

In these rooms, Blue Origin provides customer EGSE interface connection to New Glenn via a space vehicle interface panel (SVIP) as shown in Figure 5-15. Blue Origin also furnishes the mating connector halves to the customer to mate to the SVIP in the EGSE room. The SVIP provides electrical interconnection to the standard electrical interface panel (SEIP) on the fixed adapter from time-zero (T-0) umbilical installation until liftoff, as shown in Figure 5-15.

The EGSE rooms are approximately 9.3 m² (100 ft²) with 1.82 m (72 in) width by 2.43 m (96 in) tall door-clear dimensions. They are outfitted with the following 60 Hz power capabilities and additional services:

- Eight (8) NEMA L5-20R receptacles (20 A, 2 Pole, 3 Wire, 125 V)
- Two (2) NEMA L5-30R receptacles (30 A, 2 Pole, 3 Wire, 125 V)
- Four (4) NEMA L21-30R receptacles (30 A, 3 Ph, 4 Pole, 5 Wire, 120/208 V)
- Technical ground plate
- Air Quality: 20.5 – 25 °C (69 – 77 °F) @ 35 – 70% relative humidity
- Covered cable chase/pass-through
- < 6 m (20 ft) distance to interface panel

Blue Origin provides three-phase uninterruptible power to customer EGSE with the following characteristics:

Table 5-2: Electrical ground support equipment power specifications

Element	Parameters
Voltage	120/208 V ± 5%
Frequency	60 ± 1 Hz
Total harmonic distortion	Not to exceed 5%
Voltage transients	Not to exceed 200% nominal root mean square voltage for more than 20 microseconds
Maximum load	20 kVA

At the payload processing facility described in Section 8.1.2: Payload Processing Facility, 50 Hz power capabilities are available in Building 1, and in other processing buildings as part of optional launch services. The customer may also request 50 Hz power capabilities at the Blue Origin integration facility or the pad as part of optional launch services.

5.5.2 Ground to Payload Electrical Interfaces

5.5.2.1 Ground Power

New Glenn provides at least 16 shielded twisted pairs of wires per payload for purposes of external power, full-power battery charging power, trickle battery charging power, or other power services as required by the payload. All primary and secondary power leads are routed with an accompanying return lead, and each twisted pair constitutes part of a complete circuit, with a power source in the EGSE room and a load in the payload. Additional ground power lines are available as part of optional launch services.

Each twisted pair provides a maximum source voltage of 126 VDC and a maximum source current of 11 A at the SVIP interface. The maximum round-trip resistance between the SEIP and SVIP for any single pair is $1.0\ \Omega$ or less when shorted at the opposite end.

The switch from ground power to payload internal power may occur as late as four(4) minutes before launch, and liftoff / T-0 current may not exceed 100 mA.

5.5.2.2 Ground Monitoring

Blue Origin provides up to 60 shielded twisted pairs per payload at the SVIP capable of differential monitoring of payload status. Each twisted pair constitutes part of a complete circuit between the payload and its EGSE.

Each twisted pair provides a maximum source voltage of 126 VDC and a maximum source current of five(5) A at the SEIP and SVIP interfaces. The maximum round-trip resistance attributed to this cabling between the SEIP and SVIP for any single pair is $5.0\ \Omega$ or less when shorted at the opposite end.

Blue Origin also provides 8 twin-axial twisted shielded cables per payload at the SVIP for data connections between EGSE and the payload. Each cable has characteristics as shown in Table 5-3.

Table 5-3: Twin-axial cable characteristics

Element	Parameters
Wire-to-wire distributed capacitance	$\leq 98.4\text{ picofarads/m}$ ($30.0\text{ picofarads/ft}$)
Cable twists	$\geq 13\text{ twists/m}$ (4 twists/ft)
Cable shield	$\geq 75.0\%$ coverage
Characteristic impedance	$70.0 - 85.0\ \Omega$ at a sinusoidal frequency of 1 MHz
Cable attenuation at 1 MHz	$\leq 4.9\text{ dB / 100 m}$ (1.5 dB / 100 ft)

5.5.2.3 Electrical Connection Availability and Validation

During most pre-launch phases of a launch campaign, the customer has access to connect with their payload, with the main exceptions being during transportation and mating activities.

Table 5-4 below includes a summary of all electrical interface locations available during the pre-launch period. The customer is responsible for all payload cables at the payload processing facility (PPF), as well as between local EGSE and the SVIP within the EGSE rooms in the IF and at the pad. Validation of these electrical interfaces occurs after each configuration change prior to launch to ensure continuity isolation, polarity, and signal integrity.

Table 5-4: Electrical interface availability summary

Condition	Available Interfaces	Interfaces Verified
Prior to launch campaign	None	Communication paths between all control centers and local EGSE locations at PPF, IF, and pad. Control centers are located at the PPF, mission control center, and IF Power and communications from T-0 umbilical to TE connection autocoupler interface
Un-encapsulated payload processing in PPF	Direct connection to payload	Power, communications, and separation circuits from local EGSE up to the SEIP
Encapsulated payload processing in PPF	Connection to SEIP	Power, communications, and separation circuits from local EGSE up to the SEIP
Encapsulated payload transport from PPF to IF	None	None
Encapsulated payload in IF prior to integration	Connection to SEIP	Power, communications, and separation circuits from local EGSE up to the SEIP
Encapsulated payload mating and integration in IF	None	None
Encapsulated payload mated to LV on TE	Umbilical connection via IF SVIP	Power, communications, and separation circuits from IF/pad SVIP up to the T-0 umbilical interface and LV avionics via TE and upper stage
Encapsulated payload during TE rollout from IF to pad	None	None
Encapsulated payload at launch pad	Umbilical connection via pad SVIP	Power and communication circuits between the pad SVIP and TE connection autocoupler interface Separation circuit resistance from LV avionics to payload

5.5.3 Launch Vehicle to Payload Electrical Interfaces

5.5.3.1 In-flight Data and Power Connections

Figure 5-15 above shows a schematic of the dedicated payload harness interfaces, which are labeled SC-IFD1 and SC-IFD2. For these connections, located at the spacecraft interface plane (SCIP), Blue Origin provides a pair of

payload-side 37-pin or 61-pin standard connectors for the spacecraft. Blue Origin typically supplies the harness from the SEIP to the SCIP, and provides the customer with spacecraft-side IFD mating connector halves. If the customer supplies the harness from the SEIP to the SCIP, Blue Origin provides the mating connector halves to mate with the matching connectors at the SEIP as well. Current flow is limited to a maximum of 100 mA per wire for non-ordnance circuits between the payload and SEIP during the payload separation event. For more information about available standard IFD connectors and possible data interfaces, please contact Blue Origin.

In the coast phase of flight prior to separation, the launch vehicle is capable of sending pre-determined electrical signals for separation, separation verification, or other purposes to the payload via its IFD umbilical links. Pre-programmed spacecraft operations and RF communication must wait until after payload separation and payload separation +20 seconds, respectively.

5.5.3.2 Separation Connections

The pyro, or electro-explosive device (EED), harnesses attached to the fixed adapter carry the initiation signals for the payload separation event and confirm payload separation from the SEIP to the payload and back. The vehicle's avionics provide up to 12 redundant pyrotechnic separation device commands: up to four (4) to each payload in dual manifest and four (4) to the dual manifest structure, however these commands may be allocated on a mission-unique basis. The upper stage avionics measure EED firing circuit continuity from the SEIP through each EED located on the mated payload. Nominal EED circuit characteristics conform to those listed in Table 5-5.

Table 5-5: EED circuit firing characteristics

Element	Parameters
Total EED circuit resistance	> 0.9 Ω < 2 Ω
Firing signal current	> 5 A per circuit < 18 A per circuit
Pulse minimum duration	40 ± 10 milliseconds

EED firings consist of separate primary and redundant pulses, time-phased by a duration of either less than 5 milliseconds of the leading edges of the firing signals or 40 +/- 10 milliseconds between the trailing edge of the primary firing signal and the leading edge of the redundant firing signal, as depicted in the Figure 5-16.

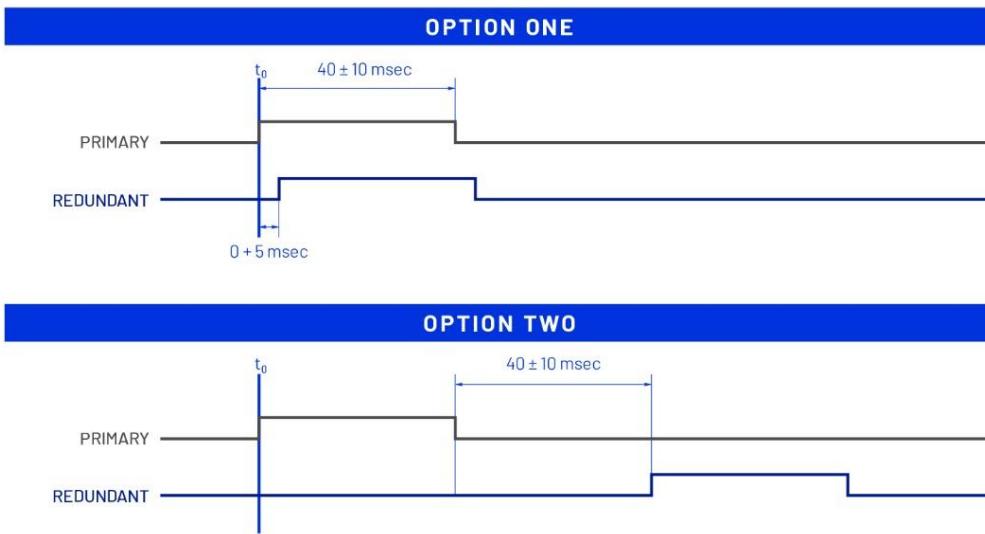


Figure 5-16: EED circuit firing timing options

The system can also provide up to 12 indications of breakwire status or separation events using up to 12 shielded twisted pairs at the SEIP. These redundant breakwire loopbacks are isolated from the payload structure by a minimum of $1\text{ M}\Omega$, have a maximum resistance of $1\text{ }\Omega$, and a minimum resistance after break of $1\text{ M}\Omega$. Separation indications are delivered to ground via launch vehicle telemetry.

5.5.4 Payload Video

New Glenn includes multiple video monitoring capabilities to capture various views of the vehicle and the payload during flight. The first stage and second stage are instrumented with multiple engineering cameras and lights to provide imagery evidence of key mission timeline events, and for general vehicle health monitoring.

Blue Origin works with the customer to develop a pre-determined sequence for switching camera feeds between them, as only a single feed will transmit to the ground at a time. The system can provide video of liftoff, ascent, stage separation, PLF jettison, and payload separation.

6.0 INTEGRATION

6.0 INTEGRATION

This section outlines the people, processes, planning, and deliverables that take customers from the signature of a Launch Services Contract (LSC) through flight aboard New Glenn.

6.1 OVERVIEW

Mission integration activities include mission planning, mission interface control document (ICD) coordination, coupled loads analysis (CLA), and coordination with various governmental authorities. The nominal mission planning timeline begins after the LSC effective date of contract (EDC), approximately 24 months or less before the desired launch, and culminates in launch of the payload into the desired orbit. High level planning milestones are shown in Figure 6-1 below. Please contact Blue Origin for more detailed integration schedules or for information about possible accelerated timelines as part of optional launch services.

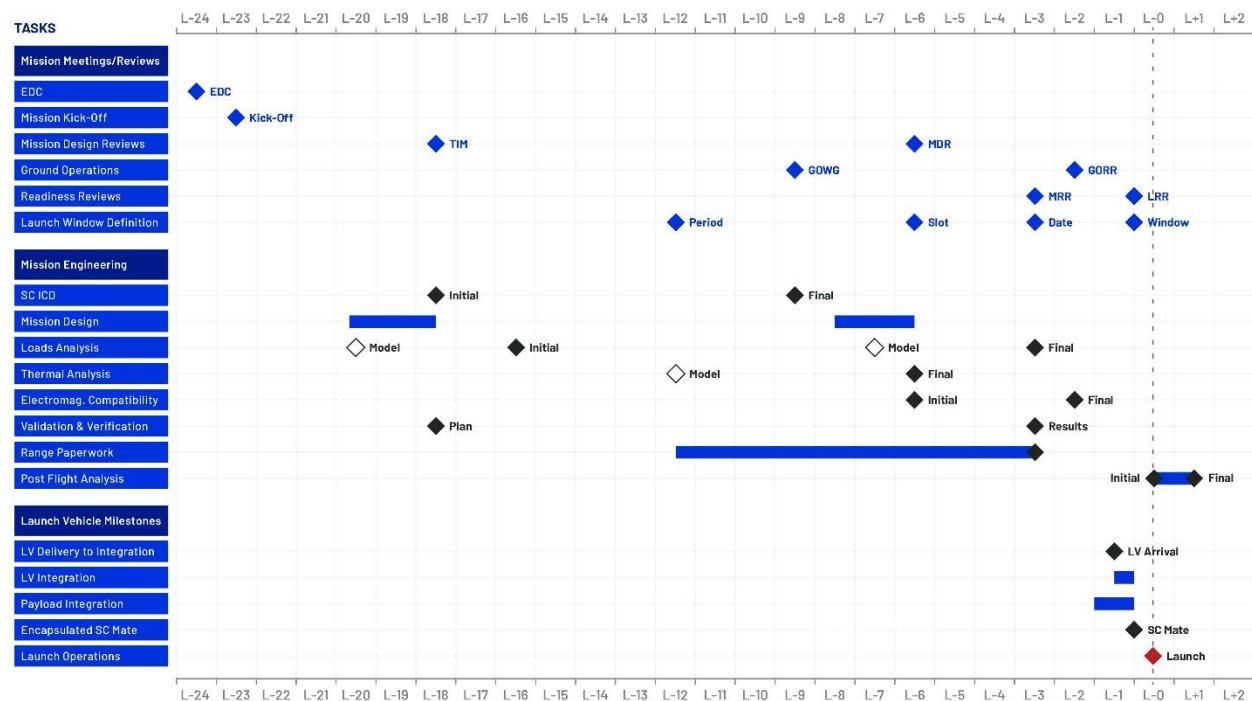


Figure 6-1: High level schedule for a 24 month payload integration process

The overall approach for New Glenn mission integration is early coordination and regular communications to ensure a successful partnership and mission. As necessary, Blue Origin will facilitate a joint Technical Assistance Agreement (TAA) to ensure compliance with the International Traffic in Arms Regulations (ITAR) and Export Administration Regulations (EAR) during the mission integration and launch period.

Process milestones, as listed in Table 6-1 below, are designed to do the following:

- Establish customer payload requirements
- Develop a mutually agreed-upon integration schedule, tailored as necessary
- Identify deliverables needed from both parties
- Provide formal reviews to ensure consistent progress towards a successful mission

These reviews cover mission design, analysis, operations, mission unique requirements, launch readiness and other contractual issues as required. Precise dates, agendas, locations, and review logistics are determined by Blue Origin in consultation with the customer. Blue Origin typically also attends any customer-led payload readiness reviews held during the integration phase.

Assuming a 24 month integration schedule, Blue Origin-led milestone reviews are held in approximately the sequencing and timing noted in Table 6-1 below. Over time, Blue Origin anticipates that the standard 24 month timeline will be reduced to <18 months for new systems and <12 months for repeat payloads.

Table 6-1: Mission integration milestone reviews

Estimated Date	Review	Purpose
EDC +1 month	Kickoff Meeting	Reviews LSC, mission requirements, and schedule; introduces integration teams, and establishes communications and correspondence
L-18 months	Technical Interface Meeting (TIM)	Covers initial mission analysis cycle, initial ICD, detail payload design, and customer V&V plan
L-9 months	Ground Operations Working Group (GOWG)	Provides a forum for coordinating all Launch site operations requirements, and covers final ICD, schedules, and procedures
L-6 months	Mission Design Review (MDR)	Covers final mission analysis cycle, customer payload safety package, and readiness to proceed with hardware in the loop testing and/or launch campaign
L-3 months	Mission Readiness Review (MRR)	Ensures all necessary data and government paperwork is complete prior to payload shipment and reviews validation & verification results
L-2 months	Ground Operations Readiness Review (GORR)	Ensures all requested ground facilities and operations are prepared for payload shipment and arrival
L-7 days	Launch Dress Rehearsal	Allows integration teams to practice procedures and prepare for operations
L-2 days	Launch Readiness Review (LRR)	Provides a final pre-launch assessment of the integrated spacecraft/Launch Vehicle system and Launch facility readiness
L+1 day	Post-Launch Review	Covers contents of initial post-launch report and contract financial status

Note that L means the first day of the launch period and, once determined, the first day of the most recently agreed launch slot. For information on determination of launch slots, see Section 7.3.1: Launch Window Determination.

In addition to design reviews, the customer must conduct verification activities related to payload mass properties and payload dynamic model correlation. Blue Origin may request insight into test procedures and review of test data.

As outlined in Section 3.6: Payload Validation and Verification, the customer leads a formal payload validation and verification (V&V) process for Blue Origin's review. This process is intended to determine compatibility with the environments in Section 4.0: Environments. Simultaneously, Blue Origin leads V&V activities for the fully integrated launch system, such as CLA, integrated thermal modeling, link margin analysis, post-separation analysis, and mission-unique environments.

6.2 INTERFACE CONTROL DOCUMENT

Blue Origin's mission ICD defines all payload to launch vehicle and payload to launch complex interfaces and associated assumptions or requirements, including but not limited to mechanical and electrical interface control drawings. Blue Origin prepares the ICD as part of the integration process and includes any necessary requirements specified in the payload interface requirements document (IRD) and any additional requirements adopted during the mission design and integration process. Once approved by both Blue Origin and the customer, the mission ICD serves as the unique governing document for configuration management and technical interface requirements, and in the event of a conflict between the ICD and the IRD or LSC statement of work (SOW), the ICD takes precedence. Changes to the ICD require approval from both Blue Origin and the customer.

6.3 INTEGRATION MANAGEMENT

The mission integration process requires close coordination among the customer, Blue Origin, and any regulatory authorities, such as the United States Air Force Eastern Test Range (Range), and the Federal Aviation Administration (FAA). The high-level organization of these customer service activities is shown in Figure 6-2 below.

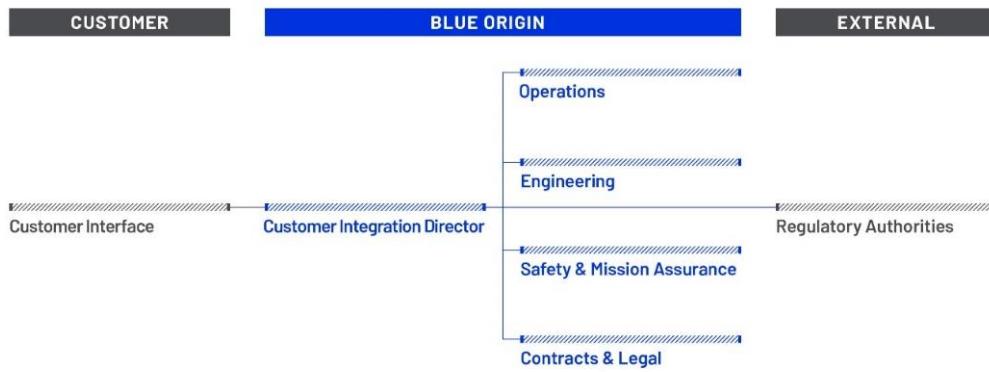


Figure 6-2: Blue Origin customer service organization

Mission integration information flow and contractual requirements are principally coordinated by Blue Origin's Customer Integration Director (CID) as the primary customer point of contact. Throughout the integration process, the CID, gathers and delivers documentation and analysis, organizes meetings and reports, coordinates reviews, oversees joint V&V activities, liaises with other Blue Origin teams on the customer's behalf, and interfaces with the customer on behalf of Blue Origin during launch campaign activities. Post-shipment of the payload, the CID has additional support from Blue Origin's Payload Integrator (PI) on day-to-day logistical and non-contractual matters to ensure timely and efficient operations.

The CID is the customer's single Blue Origin point of contact for:

- All customer communication during all mission phases
- LSC management
- Documentation submission, coordination, and compliance, for example:
 - Range submittals
 - Mission schedule
 - Mission ICD
 - Other U.S. Government coordination, including FAA licensure, and ITAR export control submissions and compliance
- All Blue Origin mission reviews and customer meetings
- Any Blue Origin participation in customer-led mission reviews
- Coordination of customer arrival and access to Blue Origin facilities

For more information, please see Section 1.4: Customer Interface.

6.4 MISSION INTEGRATION PROCESS

Mission integration is traditionally split into two phases:

- Pre-Shipment – From EDC to until just before payload shipment to the launch site
- Post-Shipment – From payload shipment to the launch site until launch

The pre-shipment phase centers around two mission analysis cycles and the preparation of various engineering documentation to ensure the safety of operations and compatibility of the payload and launch vehicle system before and during flight. Blue Origin is responsible for developing documentation, data, models, and analyses with inputs and requirements from the customer to support the mission schedule. Key customer inputs are summarized in Section 6.5: Customer Deliverables.

The post-shipment phase is also known as the launch campaign and covers standalone payload integration and combined operations for the mission. Blue Origin is responsible for providing various services, equipment, facilities, and operations personnel to support the mission schedule.

6.4.1 Pre-Shipment Services

The EDC nominally occurs 24 months prior to launch. If the customer has different schedule needs, the adjusted schedule can be incorporated into the LSC.

An initial kickoff meeting, typically held within a month after EDC, summarizes expectations from both sides and sets the stage for future technical reviews with design and operational interface requirements. The customer is asked to provide either an IRD or complete a payload questionnaire (see Appendix B: Payload Questionnaire), and provide the preliminary payload design with mass properties by the kickoff meeting.

In advance of the first mission analysis review, the customer provides a payload data package, including a full update of all technical parameters then known. Bi-directional data exchange begins as early as 18 months prior to launch via a Technical Interface Meeting (TIM), which is held to review initial mission analysis results and ensure the integration teams' efforts are aligned and coordinated. The CID establishes interfaces through a Blue Origin-controlled preliminary ICD, and the customer presents an initial payload safety package and a V&V plan that guides the flight qualification process.

If using the standard capacity fixed adapter configuration, as described in Section 3.1: Mass Properties, the customer must also provide notification of the preferred payload adapter system (PAS) interface diameter or other mission-unique separation system by approximately 14 months prior to launch. The

configuration and location of any payload fairing (PLF) access doors or radio frequency(RF)transparent windows must be determined at least 12 months prior to launch.

Formal technical reviews typically commence approximately nine (9) months prior to launch, beginning with the Ground Operations Working Group (GOWG). All ground operations requirements are discussed at this meeting, including: ICDs, facilities, timelines/schedules, reviews, ground support equipment (GSE), support services required at launch site, hazardous operations that affect outside organizations, mission-unique requirements, and operations procedures.

Detailed analysis work continues following GOWG, leading to the second formal review, the Mission Design Review (MDR), approximately six (6) months prior to launch. The MDR is held to review the results of the final mission analysis and verify that the as-analyzed system meets the requirements of the payload. The MDR marks the nominal end of the mission design analysis cycle, although additional or delta analyses may be performed as part of optional launch services. In this timeframe, the customer submits a final payload safety package, showing analysis of hazards for payload/ground operations and mitigation strategies.

A third formal review, the Mission Readiness Review(MRR), is typically held three (3) months prior to launch. The MRR ensures that all parties are ready to begin the launch campaign. The Range's approval of a Missile System Pre-launch Safety Package (MSPSP) should be complete by the MRR and is the final milestone before shipping the payload to Cape Canaveral for physical integration. The customer supplies daily launch windows for the proposed launch slot, and provides a completed set of V&V processes and results, consistent with the materials presented in the TIM.

The CID may hold additional periodic program management reviews to provide additional opportunities for status updates throughout the mission integration process.

Table 6-2 below summarizes Blue Origin's key engineering documents and services in the mission integration process. All dates are estimated based on 24 month integration schedule and may be adjusted by mutual agreement between Blue Origin and the customer. Note that documentation may require multiple iterations to meet all customer and/or regulatory requirements.

Table 6-2: Blue Origin mission integration engineering documents

Delivery Timing	Engineering Document
Kickoff (L-24 months)	Mission Requirements Summary
TIM & GOWG (L-18 & L-9 months)	Initial and final ICD between the payload and the Launch Vehicle, including: Mechanical Interface Control Drawing Electrical Interface Control Drawing Mission Design analysis assumptions
TIM & MDR (L-18 & L-6 months)	Initial and final Mission Design, including: Performance, Mass Properties, 3DOF/6DOF Trajectory, Guidance, Injection Accuracy, Launch Window, Mission Targeting, CCAM
GOWG & GORR (L-9 & L-2 months)	Initial and Final Ground Operations Plan, including: Standalone Processing timelines and procedures Combined Operations timelines and procedures Security Plan
MDR(L-6 months)	EM Interference/EM Compatibility Control Plan
MDR(L-6 months)	Cleanliness and Contamination Control Plan
MDR(L-6 months)	Validation & Verification Compliance Matrix
MRR(L-3 months)	U.S. Air Force Range Paperwork, including: Range Safety Package Launch Complex Safety Plan Integrated Hazard Analysis Breakup Analysis
Upon payload arrival (L-1 month)	Mission Constraints and Launch Checklist
T+30 minutes	"Quick Look" Post-launch Report
L+1 month	Final Post-launch Report, including: Orbital Parameters vs. Predicted Environments vs. Predicted System Performance vs. Predicted Separation State Vectors vs. Predicted Anomaly Analysis, if applicable

Blue Origin also conducts and reports the technical analyses listed in Table 6-3 below for the customer in accordance with the overall mission integration schedule. All dates may be adjusted by mutual agreement between Blue Origin and the customer. The analyses are provided in mutually agreed formats as determined at the integration kickoff.

Table 6-3: Blue Origin mission integration analysis services

Delivery Timing	Analysis	# Cycles	Notes
Volume +1 months (L-22 months)	Acoustic	1	Requires payload envelope fill factor. Assumes compatibility with predetermined acoustic models and analysis
Volume +1 months (L-22 months)	Fairing Ascent Venting and Internal Flow	1	Requires payload envelope fill factor. Assumes compatibility with predetermined venting and flow models and analysis
TIM & MDR (L-18 & L-6 months)	Performance	2	Requires payload mass, concept of operations, and mission unique requirements
TIM & MDR (L-18 & L-6 months)	Mass Properties	2	Requires payload mass properties. Conducted concurrently with performance analysis
TIM & MDR (L-18 & L-6 months)	Payload Post-Separation Clearance & Maneuver	2	Requires concept of operations, and mission unique requirements. Conducted concurrently with performance analysis
TIM & MDR (L-18 & L-6 months)	Trajectory Design	2	Requires payload mass, concept of operations, and mission unique requirements. Conducted concurrently with performance analysis
TIM & MDR (L-18 & L-6 months)	Injection Accuracy	2	Requires concept of operations, and mission unique requirements. Conducted concurrently with performance analysis
Model +4 months (L-16 & L-3 months)	Coupled Loads (CLA)	2	Requires payload dynamic model conforming to Blue Origin's requirements
Model +4 months (L-16 & L-3 months)	Payload Envelope Clearance	2	Requires payload dynamic model conforming to Blue Origin's requirements. Conducted concurrently with CLA
PAS selection & MDR (L-14 & L-6 months)	Payload Separation	2	Requires payload mass properties data, concept of operations, PAS selection notification, and mission unique requirements.
L-12 & L-3 months	Range Safety	2	Requires payload safety package, including payload breakup model and hazard data
Model +6 months (L-6 months)	Integrated Thermal	1	Requires payload thermal model conforming to Blue Origin's requirements
MDR(L-6 months)	Pyroshock	1	Requires selection of payload adapter system and shock acceptance and qualification requirements
MDR(L-6 months)	Launch Vehicle Induced Interface Vibration	1	Requires vibration acceptance and qualification requirements
MDR & GORR (L-6 & L-2 months)	EM Interference/EM Compatibility	2	Requires payload radiated emissions, susceptibility, and transmitter characteristics
MDR(L-6 months)	Cleanliness and Contamination	1	Requires contamination, deposition, and obscuration limits for all payload surfaces
MDR(L-6 months)	RF Link Compatibility and Telemetry Coverage (Airborne)	1	Requires payload receiver and transmitter characteristics
MDR(L-6 months)	End-to-End Electrical Compatibility	1	Requires payload electrical requirements
MDR(L-6 months)	Power System	1	Requires payload power requirements

Delivery Timing	Analysis	# Cycles	Notes
MRR(L-3 months)	Destruct System	1	Requires payload safety package
L-2 months	Stability and Control	1	Requires payload model
L-1 months	Mission Targeting	1	Requires final concept of operations and mission unique requirements
L-1 months	Mission Flight Software	1	Requires final concept of operations and mission unique requirements
LRR(L-2 days)	Launch Window	1	Requires payload launch window requirements

6.4.2 Post-Shipment Services

During the launch campaign, major payload-related tasks include PAS “touch and go” fit-check, payload propellant load, and encapsulated payload transport. These major requirements and all other minor tasks are monitored via a scheduling meeting, held daily by the PI beginning upon payload arrival. The typical payload processing flow and operational timeline is described in Section 7.2: Pre-Launch Operations.

The only formal review during this phase is the Launch Readiness Review (LRR), which occurs approximately two (2) days prior to launch, and is held to ensure all parties are prepared to proceed with launch operations and to confirm the final launch window.

Table 6-4 below is a representative (but not all-inclusive) list of the support services provided by Blue Origin as part of standard launch services during the launch campaign.

Table 6-4: Blue Origin launch campaign support services

Service	Description
Transportation logistics	Pickup of containerized payload and support equipment from airports listed in Section 8.1.5: Customer Logistics and transport to PPF Transport of electrical GSE (EGSE) from PPF to integration facility EGSE rooms and launch pad EGSE rooms, as necessary Recovery of EGSE from integration facility and/or launch pad EGSE rooms Return of payload container and support equipment to airport listed in Section 8.1.5: Customer Logistics
Handling and Transportation GSE	Use and operation of Blue Origin GSE, including forklifts, mobile cranes, specialty transporters, flatbed trucks, air-ride trailers, aerial lifts, aircraft loaders
Clean rooms, supply air environmental control	ISO Class 8 (Class 100,000) processing and encapsulation bays ISO Class 6.7 (Class 5,000) supply air to encapsulated volume Continuous monitoring of relative humidity, temperature and cleanliness in the PPF using particle counters for compliance with environments listed in Section 4.1.2: Thermal and Air Quality
Clean room garments	ESD coveralls, as well as shoe, beard, and head covers for customer use. Nomex suits with hoods and boots for post fueling operations can be provided if required

Service	Description
Personal protective suits	Self-contained atmospheric protective ensemble (SCAPE) air hose-type personal protective suits, splash suits, and related training and support for the customer's team to support propellant handling, transfer, and loading operations. SCAPE suit fittings and physicals must be completed prior to arrival
Ordnance handling and storage	Receiving, inspection, storage, and delivery of ordnance items. Facilities for testing of solid motors are available on a case by case basis
Commodity solvents and gases	Gaseous nitrogen (MIL-PRF-27401, Type 1, Grade B) – One (1) tubebank Liquid nitrogen (MIL-PRF-27401, Type 1, Grade B) – Two (2) dewars Gaseous helium (MIL-PRF-27401, Type 1, Grade A) – Eight (8) high pressure bottles Isopropyl alcohol (TT-I-735) – 15 gallons Demineralized water (JSC SPEC-C-20) – 100 gallons
Electrical	60 Hz facility and technical (UPS) power available in all Blue Origin facilities 50 Hz facility and technical (UPS) power available in PPF Building 1
Hazardous waste disposal	Solvents and wipes generated during the payload processing activities
Payload weighing	Per Astrotech Space Operations (ASO) Facilities Accommodations Manual
Metrology/Equipment calibration	Per ASO Facilities Accommodations Manual
Timing	GPS outputs including inter-range instrumentation group (IRIG) timing in IRIG-B120 format, one (1) pulse per second, and 10 MHz reference signals.
Intra-site communications	Dedicated dark fiber-based data, RF, and digital voice links between: LC-36 (Integration Facility and Launch Pad) and Blue Origin's mission control center (MCC) LC-36 and all PPF buildings MCC and all PPF buildings All individual PPF buildings
Payload communications	Copper umbilical link with up to 122 data/power lines per spacecraft, accessible via SVIP at EGSE room
External communications	Local internet access available in all Blue Origin facilities Standard telephone and fax available in PPF and MCC facilities. Local and international telephone calls included
Security	Closed circuit television within and around all PPF buildings, within the MCC, and at LC-36 within and around integration facility and launch pad. Credentialled access to all video of unencapsulated payload and encapsulated payload shall be accessible anywhere within Blue Origin's wide area network. Such video may be recorded or not recorded at the customer's discretion Cipher lock and/or key card access to all Blue Origin's customer facilities Physical security is present at all Blue Origin operating premises 24/7 during launch campaign
Safety	Safety briefing and facilities orientation upon payload arrival Range safety coordination of all hazardous operations First aid stations in all Blue Origin facilities Skill familiarization on mechanical ground support equipment operation, such as aerial lift, crane, and forklift Emergency medical and fire protection from local Brevard County, FL, City of Titusville, FL, while at PPF and MCC, and from CCAFS/NASA while at LC-36
Weather	Weather monitoring and prediction services, including lightning strike warning system Weather data, as requested

Service	Description
Badging	Coordination and submission of documentation for CCAFS temporary badging application on behalf of customer personnel
Blue Origin site visit support	Coordination of approvals and logistics for customer personnel to make visits to LC-36 and/or other Blue Origin facilities, as required, including hotel and amenity recommendations as requested
Administrative support	On-site, English-speaking assistant for duration of launch campaign for regional recommendations, logistics, and administrative tasks

6.5 CUSTOMER DELIVERABLES

As summarized in Table 6-5 below, Blue Origin requires the following deliverables to pass through each of the formal review processes. All dates may be adjusted by mutual agreement between Blue Origin and the customer. Blue Origin works with the customer on specific deliverables to support Range certification and FAA licensing.

Table 6-5: Customer mission integration milestones and deliverables

Receipt Timing	Deliverable	Notes
Kickoff (EDC +1 months)	IRD or completed payload questionnaire	IRD may be substituted for Payload Questionnaire if includes substantially similar information as Appendix B: Payload Questionnaire
Kickoff (EDC +1 months)	Initial payload design	Includes initial description of mass, payload bus, mechanical and electrical interfaces, propellants, physical envelope/fill factor, separation systems
Kickoff (EDC +1 months)	Initial concept of operations	Includes initial description of orbital parameters, insertion requirements
Kickoff (EDC +1 months)	Mission unique requirements	E.g., Any modifications to a standard trajectory, interface, or environment described in this Payload User's Guide
TIM -2 months (L-20 months)	Initial payload data package	Includes geometric/CAD, dynamic payload models, mass properties, RF transmitter and receiver characteristics, approach to mission-unique requirements, detailed concept of operations
TIM (L-18 months)	Validation & verification plan	As per Section 3.6: Payload Validation and Verification
TIM (L-18 months)	Initial payload safety package	Includes payload related inputs to Range safety submittals, such as hazard analysis and mitigations, payload breakup model and bill of materials, as per Range requirements
L-14 months	Payload adapter system selection notification	E.g., 937 mm, 1194 mm, or 1666 mm
L-12 months	Initial launch site integration package	Operational procedures, plans, and timelines, including those related to hazards identified in payload safety package

Receipt Timing	Deliverable	Notes
MDR -6 months (L-12 months)	Integrated thermal analysis model	Must conform to Blue Origin's thermal model requirements
L-12 months	PLF access doors and RF windows location notification	As per Section 5.2.4: Accessibility
MDR -2 months (L-8 months)	Final payload data package	Includes any updated or missing content from previous submission
MDR (L-6 months)	Camera switching sequence	As per Section 5.5.4: Payload Video
MDR (L-6 months)	Final payload safety package	Includes any updated or missing content from previous submission
MRR (L-3 months)	Validation & verification results	As per Section 3.6: Payload Validation and Verification
MRR (L-3 months)	Final launch site integration package	Includes any updated or missing content from previous submission
MRR (L-3 months)	PLF branding and logo	Vector file format such as encapsulated postscript (e.g., .EPS) as per Section 5.2.5: Branding and Logo
MRR (L-3 months)	Final launch window	As per Section 7.3.1: Launch Window Determination
MRR (L-3 months)	Pre-shipment paperwork	Including shipment inventory list and all involved customer personnel
L-1 month	Payload arrival	
L-11 days	"Go" for payload propellant load	Includes completion of non-hazardous standalone payload processing activities
LRR (L-2 days)	"Go" for launch	Includes completion of encapsulated checkout and verification that payload is ready to proceed with launch countdown
L+2 weeks	Payload tracking report	Includes observed payload orbital parameters since separation

6.6 SAFETY

Blue Origin strives to deeply understand all systems as designed. Launch vehicle systems and their payloads are inherently complex, which creates challenges in verifying their safety for overflight of the general public. Failure mode analyses and test programs are typically insufficient to discover all of the failure modes and achieve complete confidence in a design.

All parties must understand payload compatibility with the launch vehicle, as well as all potentially unsafe designs, materials, systems, or operations that may impact mission safety or reliability.

6.6.1 U.S. Government Requirements

In order to comply with U.S. Government safety documentation requirements, Blue Origin requires all customers to submit a payload safety package and a

launch site integration package, which are incorporated into Blue Origin safety submittals. Multiple iterations may be necessary to address all data requirements.

The payload safety package includes detailed bill of materials and interface schematics, data specified by Blue Origin, and data required by the United States Air Force, such as AFSPCMAN 91-710 *Range Safety User Requirements*, and FAA requirements, such as *Title 14 CFR Parts 400-460*. This data includes hazard analysis and mitigation plans, vehicle break-up models, and detailed design/test information on major elements and subsystems, such as structures, pressure systems, ordnance, telemetry, batteries, propellants, and electrical systems.

The launch site integration package includes launch site operational plans, timelines, and special service requests, as well as appropriate operating procedures for all hazards identified in the payload safety package. This data is incorporated into the ground operations plan, which becomes part of Blue Origin's safety submittals.

In addition to standard technical deliverables, Blue Origin may also require additional documentation for a commercial or non-U.S. customer mission.

6.6.2 Non-U.S. Government Payloads

As part of Blue Origin's work with the FAA to secure an operator's license for launch, payload customers may be asked to provide supporting information. This information would demonstrate that the launch does not jeopardize public health and safety, safety of property, or other national interests (*Title 14 CFR Part 415 Subpart D*).

6.6.3 Hazardous Materials and Systems

To ensure the safety of ground crews and the public, the customer is required to manage all hazards in the payload, its GSE, and any planned operations.

At the TIM review, the customer is asked to identify such hazards, including:

- Ordnance
- Other stored energy, including pressurized systems
- Lasers
- High-power RF systems
- Lifting operations
- Hazardous or toxic materials, including propellants and ground chemicals

At the MDR, Blue Origin will review mitigation plans for each significant hazard. Such mitigations may include, in order of preference:

- Engineering Controls (hardware design for redundancy or isolation)

- Administrative Controls (procedures for controlling access to the hazard), and/or
- Personal Protection Equipment (PPE).

In most cases, operational customer personnel will receive facilities safety training and orientation upon arrival of the payload. Based on the severity and likelihood of each hazard, additional mitigation may be requested. Final approval must be given by both Blue Origin and the Range.

6.7 EXPORT COMPLIANCE

U.S. export control laws impose restrictions on access to certain items and release of certain technical information to non-U.S. personnel. To comply with these laws Blue Origin may require export compliance review of deliverables, or integration activities, including, but not limited to, other items covered in this Payload User's Guide, such as any requests for non-U.S. personnel to visit Blue Origin facilities.

6.8 POLICIES

Reserved.

7.0 OPERATIONS

7.0 OPERATIONS

This section provides an overview of Blue Origin's expected concept of operations and all activities leading up to and after launch. The planned annual launch rate for New Glenn is 12 missions per year based on a monthly launch cadence.

7.1 TYPICAL LAUNCH TIMELINE

For New Glenn, Blue Origin is targeting a 30-day launch campaign, beginning the day that the customer's payload arrives at the airport if shipped by air, or at the payload processing facility (PPF) if shipped by land. While longer campaigns can be accommodated, standalone customer operations typically last about 22 days, which can be split between non-hazardous and hazardous processing at the customer's discretion. Combined operations involving both Blue Origin and customer teams typically begin seven(7) and no more than 11 days before launch. A notional timeline is shown in Figure 7-1 below, but note that duration of preparations can vary based on the degree of payload processing and propellant loading required. This timeline does not include additional time for electrical ground support equipment (EGSE) preparations and transportation.

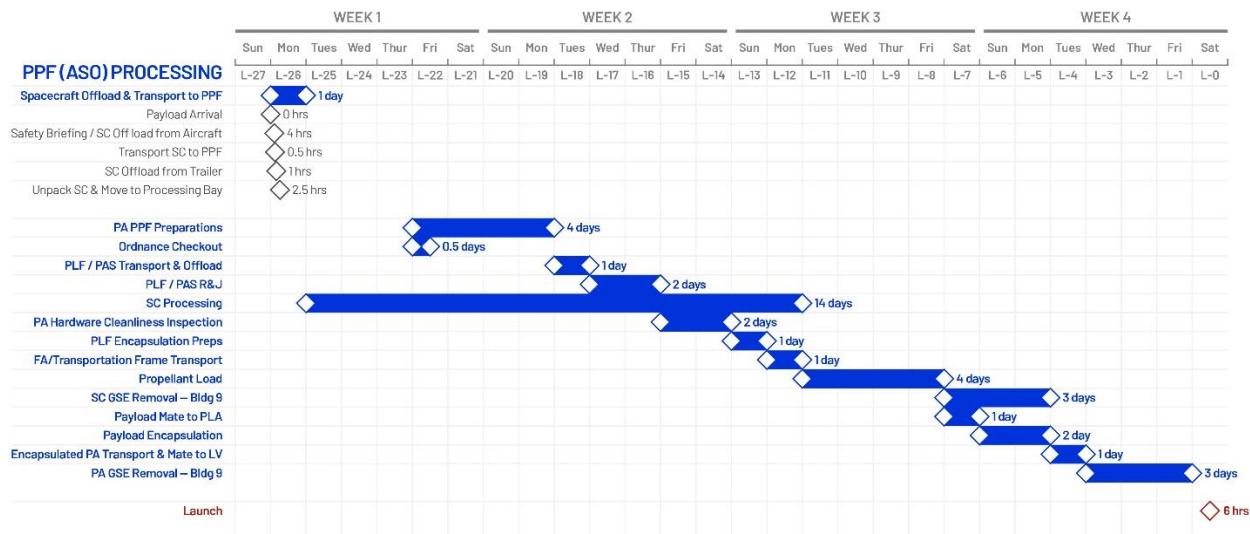


Figure 7-1: Notional payload arrival to launch timeline

7.2 PRE-LAUNCH OPERATIONS

7.2.1 Payload Processing Flow

The payload nominally arrives via air or ground transport to the PPF no earlier than 30 days before the scheduled launch date, or as specified in the Launch Services Contract (LSC). This delivery date allows sufficient time for processing

and propellant loading by the customer before combined operations start, including payload encapsulation, integration checks, and transport to the integration facility (IF). If payload propellants are shipped by sea instead of purchased locally, Blue Origin will support the customer in organizing ground transport of propellants to the PPF.

Nominal payload processing lasts two (2) to three (3) weeks, with propellant loading beginning on L-11 days and completed within four (4) days. After that, the payload to payload adapter system (PAS) mate, payload to fixed adapter mate, and payload encapsulation finish between L-8 and L-5 days from planned launch date. Encapsulation is completed within one (1) day to be ready for transport to the IF by L-4 days. As necessary for late access, the payload remains vertical until at least five (5) days before launch, after which the payload is mated to the launch vehicle in the integration facility(IF). Later physical access via the payload fairing (PLF) access doors is possible until L-2 days.

7.2.2 Encapsulation and Vehicle Integration

Encapsulation occurs in a vertical configuration at the PPF following all propellant loading and other physical payload processing activities. Blue Origin can start encapsulation as early as 11 days before the scheduled launch date, but nominally begins approximately six (6) days beforehand to minimize combined operations duration. The PLF, PAS, and fixed adapter are delivered to the PPF from the manufacturing complex in advance of encapsulation between L-18 and L-12 days.

Once ready, crews move the PAS into the payload's designated processing bay, after which they lift the payload onto the PAS for mating using a crane. The fixed adapter, which is mounted on the payload transportation frame, is then moved into the payload's designated processing bay. Next, the assembled payload and PAS are hoisted onto the fixed adapter and mated. The completed assembly then moves on air bearings into the encapsulation bay, where the PLF halves are staged for encapsulation.

In the case of dual manifest with a very tall upper berth payload, the crews first transfer the lower berth payload into the encapsulation bay. They then move the dual manifest structure into the encapsulation bay, where they lift it with a crane, place it over the lower berth payload, and mate it to the fixed adapter. Finally, the upper berth payload (already mated to its PAS) moves on air bearings into the encapsulation bay, and is hoisted atop the dual manifest structure just prior to encapsulation.

The encapsulation operation involves the installation of the PLF halves around the payload(s) onto the fixed adapter. The PLF halves are pre-mounted within ground support equipment (GSE) called strongbacks that elevate and precisely align and position them during installation over the payload transportation frame

and onto the fixed adapter. Typical encapsulation steps are depicted in Figure 7-2 below.

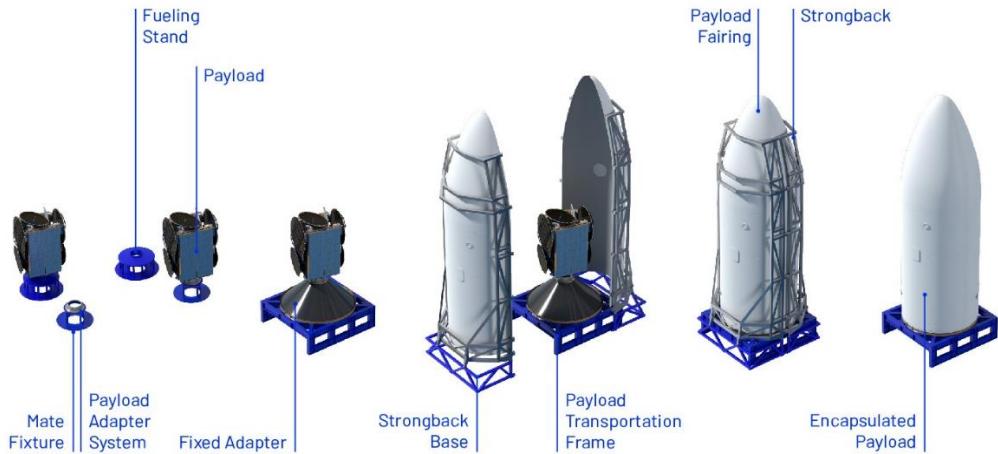


Figure 7-2: Typical payload encapsulation steps

Cleanliness levels are maintained in the PPF high bay when accessing the encapsulated payload, as well as the cleanliness of the air supply for the environmental control system (ECS) (see Section 4.1.2: Thermal and Air Quality for environmental requirements).

Once encapsulated, the customer may use up to two (2) radio frequency (RF) transparent windows that can be located on the PLF to allow for RF radiation and interrogation of the encapsulated payload in the PPF to verify spacecraft communication prior to transport to the IF.

At L-4 days, the encapsulated spacecraft is then transported vertically on the payload transportation frame via specialized transporter to minimize induced loads during its pre-coordinated 32 km (20 mi) overnight journey from the PPF to the IF at Launch Complex 36 (LC-36). ECS remains active during the entire transition to maintain a suitable enclosed environment for the spacecraft.

Upon arrival at the IF, Blue Origin positions the encapsulated payload into an open service bay for horizontal integration and mate with the launch vehicle based on industry best-practices, as shown in Figure 7-3 below. A breakover GSE module is attached to the aft of the fixed adapter, and the PLF is rotated 90° into a horizontal orientation. Once the breakover is complete, the breakover module is positioned by the horizontal mate GSE module. The horizontal mate module aligns and connects the encapsulated payload to the launch vehicle, utilizing fine control and limited six degrees of freedom (6DOF) to account for lateral offsets and axial misalignment between the fixed adapter and launch vehicle. During the mating process, all loads on the encapsulated payload are recorded to verify they remain within the envelope described in Section 4.1.1: Acceleration Loads, Ground Processing. ECS remains active throughout the entire mate operation

with conditioned air, and once integration is completed, the breakover module and horizontal mate module are removed. Horizontal integration of the PLF to the launch vehicle takes approximately 8-10 hours to complete, and results in a fully integrated launch vehicle (ILV).

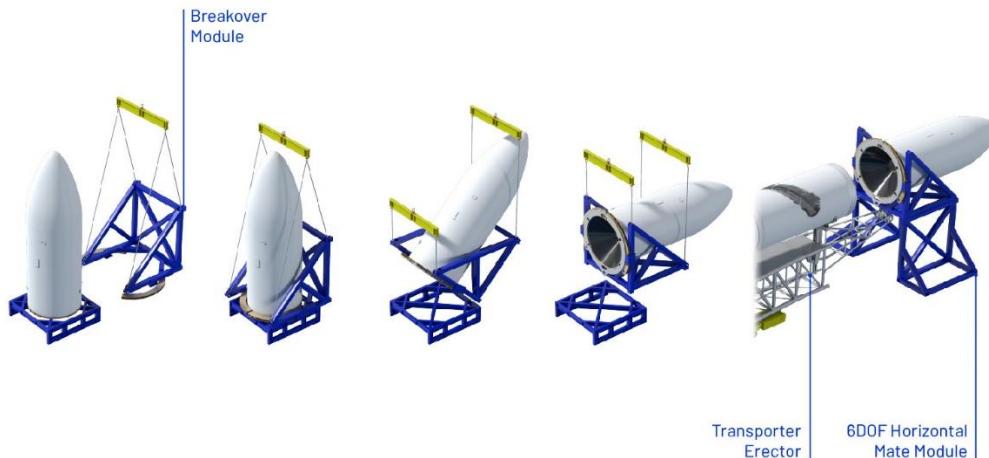


Figure 7-3: Horizontal Integration approach

Once mated in the ILV configuration, the last standard access to the payload via fairing doors occurs no later than two (2) days before launch, although later access may be possible as part of optional launch services. Please contact Blue Origin with specific requirements.

7.2.3 Rollout to the Pad

Upon completion of integration, the ILV is transported on the transporter erector (TE) to the launch pad via wheeled transporters. The IF and the launch pad are separated by 670 m (2,200 ft) of 3°-inclined ramp. Portable ECS travels with the TE during the rollout period to ensure consistent thermal and humidity environments within the encapsulated volume are maintained. Upon arrival, the TE upends the ILV and the launch table is nominally set on the launch pad deck within 75 minutes of beginning rollout.

7.2.4 Pad Operations and Countdown

The New Glenn concept of operations baselines a five (5) to six (6) hour timeline between beginning of rollout to the pad and launch of the vehicle, depending on the duration of preplanned holds, as shown in Figure 7-4. As part of optional launch services, Blue Origin can extend the countdown prior to propellant loading in a vertical orientation at the pad for additional time to accommodate payload verification and checkout timelines. Please contact Blue Origin for more information about non-standard countdown operations.

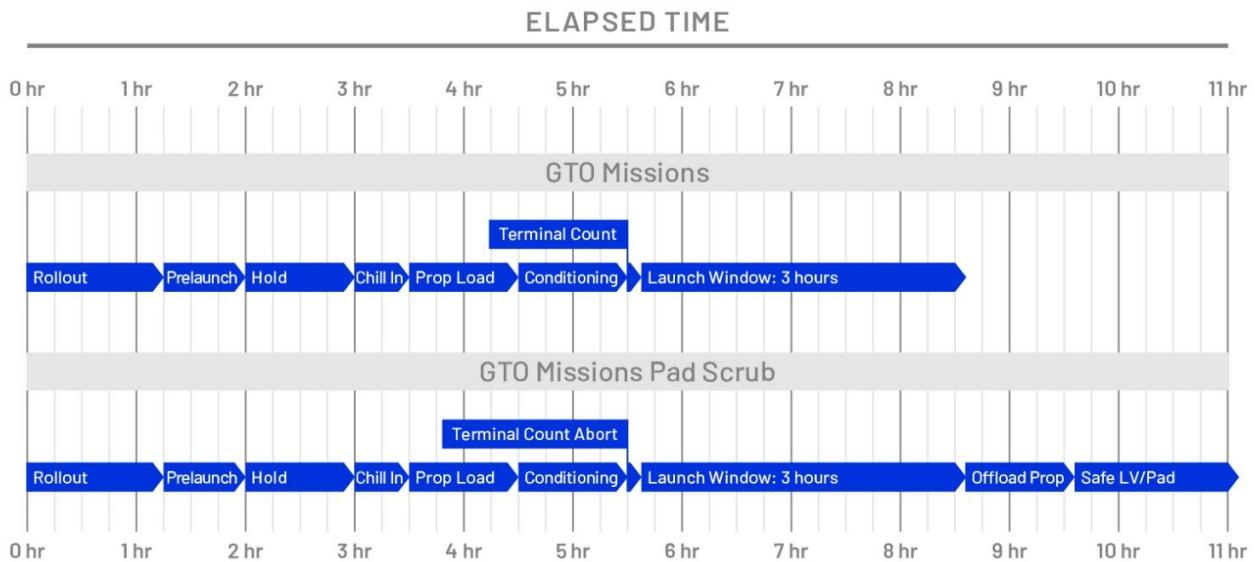


Figure 7-4: New Glenn launch operations timeline

Once the ILV arrives at the launch pad on launch day, a series of events and final systems checks take place in the final hours before launch:

- Connect ECS supply to continue conditioning of encapsulated payload
- Install ILV on pad
- Mate/establish GSE connections
- Upend ILV to vertical and secure for launch
- Run pre-launch checks to verify ILV and ground systems are ready
- Clear pad for propellant transfer
- Secure launch area, airspace, and downrange flight corridor
- Load and top-off of propellants and gasses
- Arm energetics and remove safing plugs
- Clear pad and flight exclusion zone

The timeline of operations for a typical low Earth orbit (LEO) or geostationary transfer orbit (GTO) launch is listed in Table 7-1 below.

Table 7-1: Launch day timeline of operations

Activity	Duration	Total Elapsed Time
Rollout and erecting of ILV on launch pad	75 min	75 min (1.25 hr)
ILV readiness checks	45 min	120 min (2 hr)
Planned hold prior to propellant load	60 min	180 min (3 hr)
Chill-in prior to propellant load	30 min	210 min (3.5 hr)
Propellant loading	60 min	270 min (4.5 hr)
Propellant conditioning	60 min	330 min (5.5 hr)
Terminal count	10 min	340 min (5.67 hr)

Prior to terminal count, final confirmations are given by the customer, vehicle controllers, and by ground systems controllers that the payload and ILV are "Go" for launch. The system performs final built-in-test functional actuated system checks for the landing gear system, forward fins, and BE-4 thrust vector control. The autonomous terminal count procedure begins at 10 minutes before the beginning of the mission's targeted launch window, and immediately following propellant loading and conditioning.

Launch vehicle and ground conditions are monitored from the launch control center (LCC), while the payloads are monitored from both the PPF and the mission control center (MCC). On-board hydraulic, power, and telemetry are enabled with final telemetry checks to verify communication between the vehicle, engine processors, and navigation systems.

Auto sequence starts at T-2 minutes with initiation of tank pressurization, switch over to on-board auxiliary power units and pneumatic supply, and command of navigation to flight mode.

Just prior to the activation of water suppression systems, approximately thirty (30) seconds before launch, is the customer's final opportunity to hold or abort the terminal count. Engine built-in-test functional checks verify the propulsion system is ready to command full engine power at launch commit. Once the BE-4 controllers relay the signals that all engines are in nominal condition for launch, the flight computer issues the launch commit command. This command triggers engine throttle up to full thrust and releases the hold down mechanisms. The flight computer arms the autonomous flight safety system, and New Glenn lifts from the pad.

Figure 7-5: New Glenn launch from LC-3



7.3 LAUNCH WINDOWS

Launch window times and durations vary based on destination and injection accuracy requirements. Missions may have a small, instantaneous (i.e., less than one (1) second) launch window that is only conducive to a very specific orbit, or may be several hours long. New Glenn is designed to handle any launch window on any day of the launch slot with a duration between instantaneous and at least three (3) hours for GTO missions. Longer launch windows may be possible as part of optional launch services; please contact Blue Origin for information.

7.3.1 Launch Window Determination

By agreement of Blue Origin and the customer, the launch date is refined under the LSC per the process shown in Table 7-2.

Table 7-2: Launch window definition process

Launch Timing	Definition	When Defined
Launch Period	Period of three (3) consecutive months	At contract execution
Launch Slot	One (1) calendar month	No later than six (6) months before the first day of Launch Period
Launch Date	Specific calendar date	No later than three (3) months before the first day of Launch Slot
Launch Window	Specific time period on Launch Date	No later than the Mission Readiness Review

Launch window nomenclature is clarified below.

- **Launch Period** means a period of three (3) consecutive calendar months defined in the LSC.
- **Launch Slot** means a period of one (1) calendar month within a launch period with daily launch window possibilities.
- **Launch Day** or **Launch Date** means the calendar date within a launch slot on which the launch is scheduled to occur.
- **Launch Window** means a time period within the launch day when New Glenn can launch the customer's payload to the desired orbital parameters and separation conditions.
- **Launch Time** means the instant, within the launch window, that the ignition of the seven (7) BE-4 engines are scheduled to take place, as defined in hours, minutes and seconds (GMT Universal Time). The initial launch time shall commence immediately upon the opening of the launch window.
- **Launch** means the point in time at which the payload-carrying launch vehicle's flight manager software issues the "commit to launch" command to intentionally ignite and bring the first-stage engines to full thrust.

The customer (or the payload manufacturer) typically supplies potential launch windows for each day in the launch slot based on the Final Mission Analysis by the Mission Readiness Review. The final launch window is confirmed by Blue Origin and customer at the Launch Readiness Review. Any additional changes to the launch window is subject to formal agreement of both parties.

7.3.2 Recycle Capability

Should anything delay or interrupt a terminal count operation, standard procedure is to recycle operations and begin again at T-10 minutes. This recycle can occur as many times as necessary while the current launch window is still open. If delays occur that push the launch outside of the required launch window, the mission will scrub for the day and resume at the next available launch window opportunity, typically the following day.

Assuming weather and regulatory constraints are met, the probability of launching at the scheduled launch time is projected to be at least 99%. This schedule reliability is due in part to robust (greater than average 70th percentile) weather availability requirements at the launch and recovery sites, allowing New Glenn to launch and land despite significant sustained and gusting winds. Additionally, such mission critical reliability partly derives from single-sensor loss tolerance against any sensor loss that might otherwise delay the mission.

New Glenn launch infrastructure is designed for agile operations with sufficient consumables storage capability to allow for a launch attempt, scrub, and reattempt within 48 hours without resupply. New Glenn can remain at the launch pad as long as 10 consecutive days before needing to return to horizontal orientation and roll back to the IF.

7.4 LAUNCH

The flight of New Glenn is controlled autonomously on-board the launch vehicle with no flight control inputs from the ground. During the initial seconds of flight, the control system steers the vehicle away from the launch pad structures and the vehicle rolls to orient antennas to an optimal position for communications. As the vehicle ascends and accelerates, it monitors various loading conditions (e.g., dynamic pressure, angle of attack, peak payload acceleration) and steers and throttles as necessary to maintain acceptable environments.

Launch site assets track the vehicle through loss of signal, with downrange telemetry being relayed back to the MCC via ground stations and satellite links.

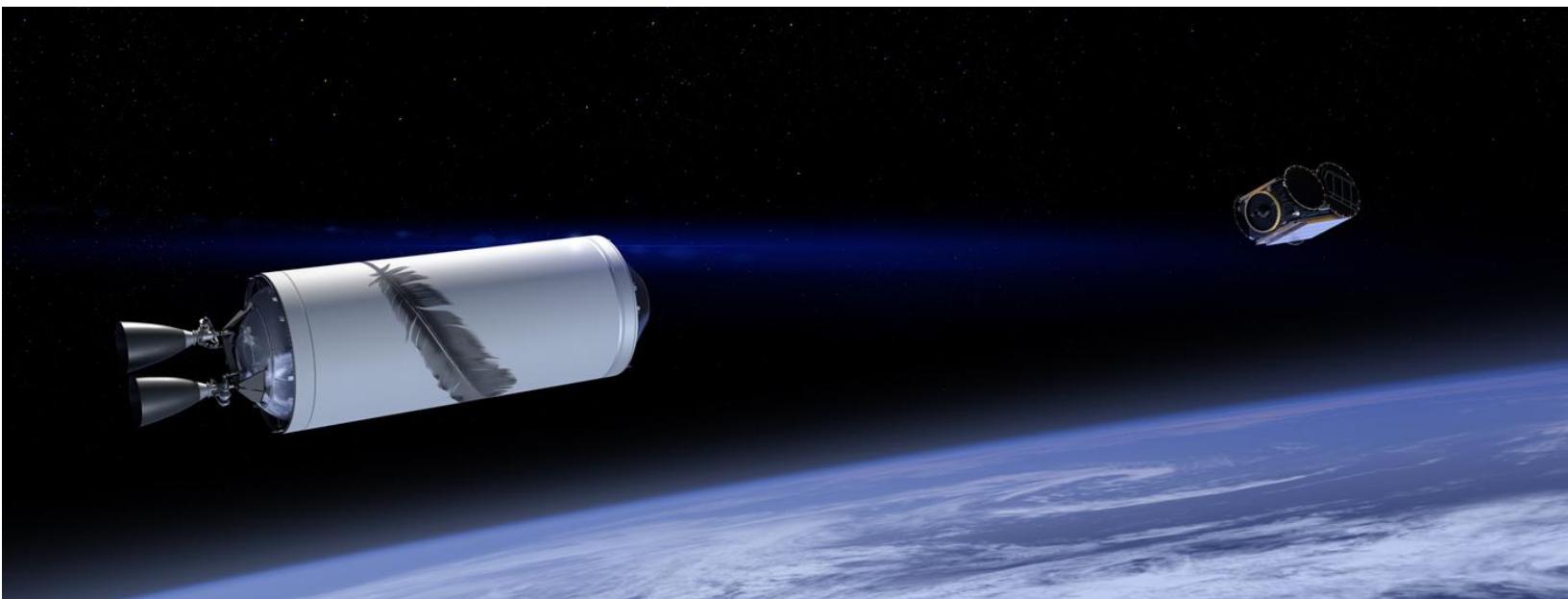
The staging point maximizes performance while also permitting the safe and successful recovery of the first stage. The sequence of events immediately after stage separation are designed to preclude re-contact between the stages, mitigate the exposure of the reusable first stage to the plume of the igniting BE-

3U engines on the second stage, and quickly establish attitude control of the first and second stages.

After the second stage ignites and burns through orbital insertion conditions, the engine shuts down and the payload separates. See Table 2-1 in Section 2.2: Mission Profile for notional timelines from liftoff through payload separation.

The stage performs a contamination and collision avoidance maneuver (CCAM) and awaits the proper time to initiate a deorbit maneuver that will lead to either a destructive re-entry over an expanse of uninhabited ocean, or insertion of the stage into a safe disposal orbit. Meanwhile, the first stage orients for the correct reentry attitude, and activates its aerodynamic control surfaces and reentry elements.

Figure 7-6: Payload separation



7.5 POST-LAUNCH SERVICES

After the mission, Blue Origin provides the customer with detailed post-launch reports that include evidence of successful separation, payload state information up to separation initiation, and the state of the final stage of the launch vehicle through separation and the completion of final maneuvers. Blue Origin derives the separation state vector data from the launch vehicle telemetry sent prior to and as close as possible to separation.

Initial post-launch reports, including estimated payload injection orbital parameters and epoch, are compiled and delivered within 15 minutes of payload separation, followed by a final analysis within 30 days.

8.0 FACILITIES

8.0 FACILITIES

This section provides an overview of Blue Origin's operational infrastructure and locations, including customer operating areas.

Blue Origin's main operational facilities and launch site are located in Florida, with a system of systems that supports manufacturing, pre-launch operations, propellant loading, long duration static fires, and full launch operations. Pre-launch facilities include the payload processing facility (PPF) and Blue Origin's manufacturing complex, which incorporates the New Glenn launch control center (LCC) and mission control center (MCC). Additional operating locations are spread across the United States, including Washington, Texas, and Virginia.

8.1 MANUFACTURING, PROCESSING, & LAUNCH SITE, FLORIDA

Blue Origin is developing both a launch site at Launch Complex 36 (LC-36) within Cape Canaveral Air Force Station (CCAFS) and a New Glenn manufacturing complex at Exploration Park, as shown in Figure 8-1. Co-locating manufacturing and launch site maximizes operational efficiencies from LC-36. When combined with an existing commercial PPF in nearby Titusville and the commercial deep water seaport in Port Canaveral, the region supports and facilitates fully commercial reusable spaceflight operations.



Figure 8-1: New Glenn launch site, Florida

8.1.1 Manufacturing Complex and Mission Control Center

New Glenn is manufactured in a purpose-built facility less than 2 km (1 mi) from the NASA Kennedy Space Center (KSC) Visitor Complex on Merritt Island, approximately 17 km (11 mi) from LC-36. Designed with 70,000 m² (750,000 ft²) of state-of-the-art advanced manufacturing, assembly, and operations space, the manufacturing complex is the hub of Blue Origin's activities in Florida.



Figure 8-2: New Glenn manufacturing complex

The facility is the site for manufacturing of all major vehicle assemblies for the New Glenn launch system. These assemblies include all vehicle tanks, the first and second stages, the payload fairing (PLF), and the fixed adapter. Production capabilities on-site are designed to support 12 missions per year.

The complex also houses a variety of payload customer operational areas, including the LCC, MCC, viewing balcony, and customer meeting rooms.

Beginning with the Launch Readiness Review (LRR) at L-2 to L-3 days, the customer enjoys 24/7 access to the MCC within the manufacturing complex for monitoring of final launch vehicle integration, rollout, and pad operations.

Multiple duplex fiber circuits between the MCC and LC-36 provide gigabit-class bandwidth to payload customers. Accommodations include dedicated customer / VIP interior space on the top floor of the facility within and adjacent to the MCC, as shown in Figure 8-3 below. In addition to mission viewing areas with seating for 20-30 customer guests and personnel, this facility includes restrooms, a work area, a food and beverage lounge, meeting rooms, and large flexible open space with access to an outdoor viewing balcony.



Figure 8-3: Mission Control Center customer / VIP accommodations

8.1.2 Payload Processing Facility

Blue Origin's PPF will be provided by Astrotech Space Operations (ASO) in Titusville, FL, located 16 km (10 mi) west of the manufacturing complex and 32 km (20 mi) west of the launch pad at LC-36. ASO is the only local commercial fueling and encapsulation facility capable of accommodating the ingress/egress of the encapsulated payload. Blue Origin includes as a commercial service all standard ASO services and facilities for assisting customers with propellant loading, checkout, and encapsulation of their spacecraft.

ASO is a well-known and respected service provider in the space launch industry with extensive experience, facilities, and capabilities for hazardous and non-hazardous payload processing operations, payload and hardware storage, and customer office accommodations. With nine (9) buildings, ASO provides more than 10,000 m² (107,000 ft²) of customer-accessible areas, described below. The

PPF has the capacity to accommodate five (5) simultaneous non-hazardous 5-meter class payloads and three (3) simultaneous hazardous 5-meter class spacecraft at the same time, last demonstrated in 2009. ASO and Blue Origin have confirmed the encapsulation facilities in Building 9 are sized to accommodate Blue Origin's 7-meter PLF concept of operations.

ASO buildings have interlinked voice, data, and video circuits, as well as internet and gigabit-class fiber connectivity to LC-36 and the MCC. Circuits from ASO to other off-site customer facilities are also possible.



Figure 8-4: PPF at Astrotech Space Operations – Building 9

The PPF can also store and load payload pyrotechnics and hazardous fluids for payload processing and encapsulation. Propellants are loaded in an isolated service bay, a “fueling island” that has the capability to collect and dispose of propellant in the event of a leakage or escape of hazardous material from the payload. The facility meets all relevant environmental and occupational health requirements and is designed per Department of Defense standards. ASO's hazardous processing accommodations include an explosion-proof design, bi-propellant fueling capability, all standard commodity fluids and gases, and spin stabilized balancing capacity of 8,400 kg (18,500 lbm). Most importantly, ASO provides high-quality, climate-controlled, ISO-8 and ISO-7 clean, and secure working facilities for use in preparation of payloads for flight.

Customers have access to a dedicated processing bay in ASO Building 1 (see Section 8.1.2.1: Building 1) for non-hazardous processing, including a high bay, the associated garment change room, a control room, and contiguous office area for the duration of the launch campaign.

During hazardous processing and combined operations, customers have access to a separate dedicated processing bay in ASO Building 9 (see Section 8.1.2.3: Building 9), including a high bay, the associated garment change room, and a control room.

Additional standard and overflow customer office space is available in ASO Building 5 (see Section 8.1.2.2: Building 5).

The PPF is available 24/7 beginning upon arrival up to 30 days prior to launch, and up to five (5) days afterward. Earlier and/or longer access is possible for unique requirements. Please contact Blue Origin with specific facilities needs or for more information on the PPF capabilities.

8.1.2.1 Building 1

Blue Origin provides a variety of clean and secure work spaces for the customer before, during, and after the launch campaign as part of standard launch services. The customer has access to a dedicated office room (minimum area of 91.5 m² (985 ft²)), control room (minimum area of 112.5 m² (1,211 ft²)), and high bay facility and garment room (minimum area of 218.4 m² (2,351 ft²)) within ASO Building 1 (see Figure 8-5), as well as shared access to the conference room, kitchenette facilities, and the main airlock for equipment staging and handling. This facility features 60 Hz and 50 Hz conditioned and non-conditioned power.

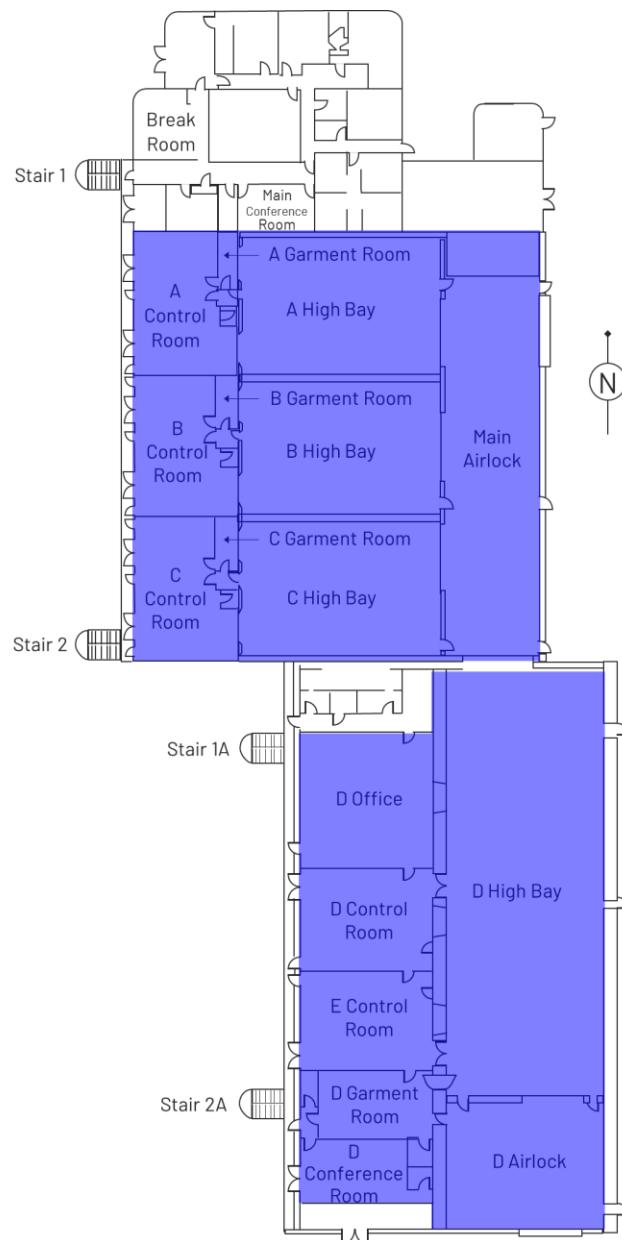


Figure 8-5: PPF ASO Building 1 customer facilities

8.1.2.2 Building 5

Two (2) dedicated offices with minimum area of 10.4 m² (108 ft²) each in ASO Building 5 (see Figure 8-6 below) are included as part of standard launch services. Shared access to conference rooms, teleconference area, and reception areas is also included for the duration of the launch campaign. Additional separate office spaces can be made available as part of optional launch services for multiple payload teams in ASO Building 5, such as for operators and manufacturers. This facility features 60 Hz conditioned and non-conditioned power.



Figure 8-6: PPF ASO Building 5 customer facilities

8.1.2.3 Building 9

Hazardous operations and encapsulation activities occur within ASO Building 9 (see Figure 8-7 below). The customer has access to a dedicated control room (minimum area of 80.8 m^2 (870 ft^2)), and high bay facility (minimum area of 282.5 m^2 ($3,041 \text{ ft}^2$)) and garment room within ASO Building 9, as well as shared access to propellant cart rooms, and the main airlock for equipment staging and handling. This facility features 60 Hz and 50 Hz conditioned and non-conditioned power.

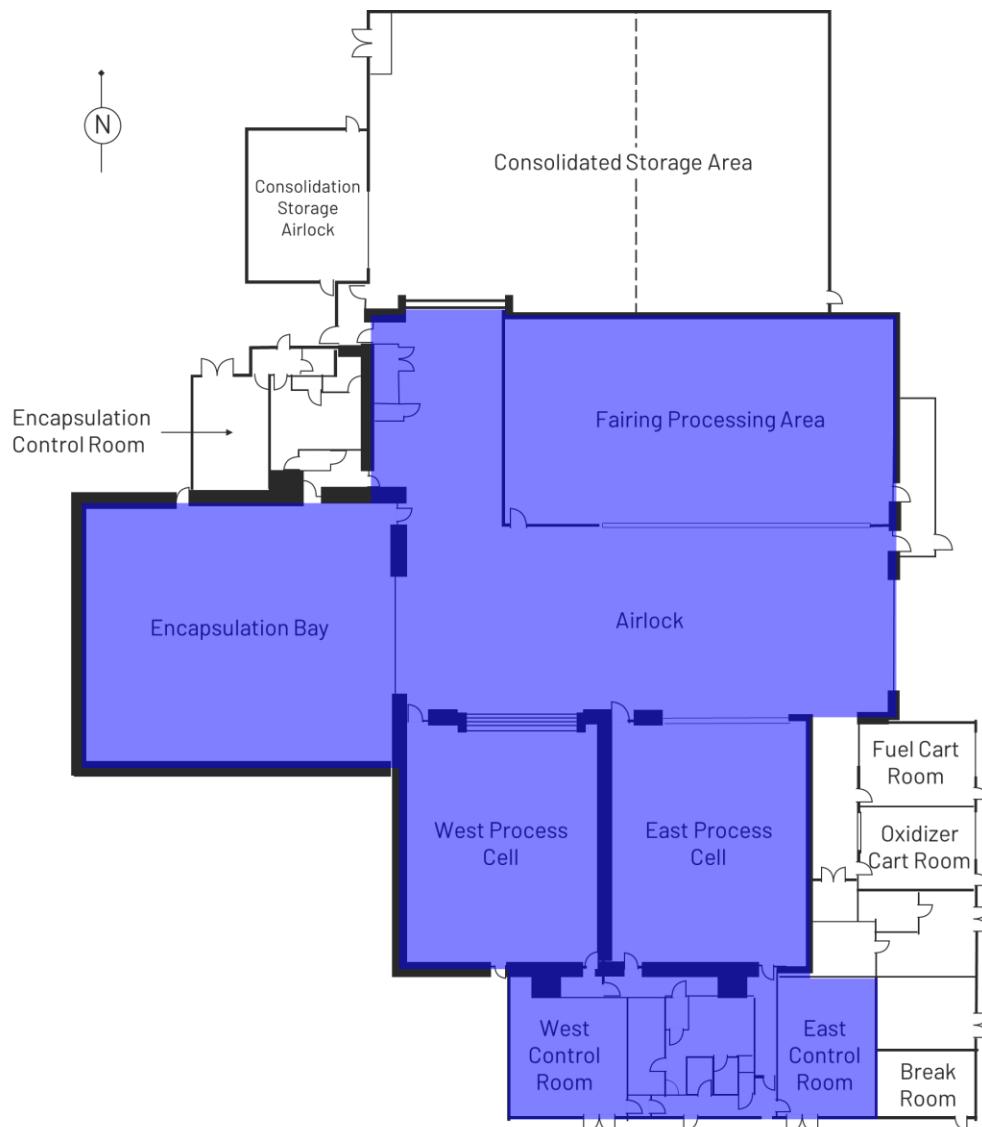


Figure 8-7: PPF ASO Building 9 customer facilities

8.1.2.4 Other PPF Storage

Additional ASO facilities for conditioned and unconditioned equipment storage are included as part of standard launch services.

ASO Building 3 provides a dedicated, conditioned bay with minimum area of 51 m² (550 ft²) for the duration of the Launch Campaign. Environment temperature is selectable per the ASO Facilities Accommodation Manual.

ASO Buildings 4 and 6 provide shared use of warehouse facilities for storage of flight hardware and GSE totaling more than 859 m² (9250 ft²) and of bonded storage area of 18.5 m² (200 ft²) for the duration of the Launch Campaign. For more information, please contact Blue Origin or see the ASO Facilities Accommodation Manual.

8.1.3 Launch Complex

New Glenn operates from property on CCAFS encompassing both LC-36 A & B pads. Prior to Blue Origin's tenancy, LC-36 hosted 145 Atlas launches spanning over four decades, including a variety of communication, defense, and exploration missions. The new launch pad at LC-36 has an integrated launch vehicle(ILV)vertical axis location at 28°28'18.61" N, 80°32'17.23" W, and is situated at the eastern end of Cape Canaveral to minimize overflight risk. Inclinations between 28.5° and 57° are possible with direct launch azimuths out of the site. Trajectories to equatorial orbits are also possible, subject to vehicle performance constraints (See Section 2.1: Launch Site for more information).

The 306.4 acre complex will contain numerous launch infrastructure elements to enable operations, as listed in Table 8-1 and shown in Figure 8-8. The LC-36 site includes the launch pad, ramp, and all required fluid commodities. The LC-36 site also has the integration capacity to support multiple concurrent horizontal operations in support of an annual launch rate of 12 missions per year.

Table 8-1: LC-36 infrastructure elements

LC-36 Element	Element Purpose
1. Launch Pad	Supports New Glenn vehicle during pre-launch and launch
2. Integration Facility (IF)	Accommodates final vehicle assembly, preparation and transport to the launch pad
3. Refurbishment Building	Permits refurbishment and preparation of the recovered first stage booster for the next launch
4. Pad Water Tower	Supplies the water for the flame deflector and for noise suppression, allowing for attempt, scrub and reattempt within 48 hours without resupply
5. GSE Storage	Houses specialized ground support equipment for the launch vehicle and all other site infrastructure
6. Lightning Protection System	Protects launch vehicle, crew, and infrastructure from induced lightning strikes

LC-36 Element	Element Purpose
7. Propellant Storage	Supplies the fuel, oxidizer, and pressurant for the launch pad and allows for attempt, scrub and reattempt within 48 hours without resupply
8. Unpopulated Buffer	Fulfils regulatory requirements on land surrounding the launch pad with a clear corridor to the ocean
9. Launch Pad Ramp	Enables travel of the New Glenn launch vehicle on the transporter erector to the launch pad deck.
10. Launch Table	Interfaces mechanically between the launch pad deck and the New Glenn launch vehicle while mounted to the transporter erector
11. Launch Pad Deck	Supports the launch table that acts as the primary structure supporting the New Glenn launch vehicle in its launch ready position
12. Flame Deflector	Mitigates the high heat flux plume impingement using an ablative coated concrete deflector with a water-cooled steel insert
13. Flame Duct	Funnels exhaust away from the pad using a concrete structure at the exit of the flame deflector



Figure 8-8: LC-36 site layout

8.1.4 Ground Support Equipment

Blue Origin supplies all customary handling and transportation ground support equipment (HTGSE) necessary for movement of the payload(s) between arrival and launch, whether transporting by barge, road, rail, or air. The HTGSE includes equipment such as forklifts, mobile cranes, specialty transporters, flatbed trucks, air-ride trailers, aerial lifts, and aircraft loaders. The customer provides any highly specialized, mission-specific HTGSE.

After unloading of the payload(s) at the PPF, the payload(s) and associated GSE are moved to the appropriate areas of the facility for inspection and checkout, hazardous and non-hazardous testing, fueling, adapter mating, and PLF encapsulation. Upon completion of these PPF activities, the encapsulated payload is transported to the IF for horizontal integration with the launch vehicle,

while the customer electrical ground support equipment (EGSE) are transferred to the IF and/or launch pad as necessary.

Separate EGSE rooms designed to meet the Evolved Expendable Launch Vehicle (EELV) Standard Interface Specifications (SIS) are available for each payload within the IF and below the launch pad for storage of payload monitoring/checkout racks and other equipment, as per Section 5.5.1: Ground Support Equipment Electrical Interfaces.

A combination of HTGSE is used in the IF for the handling of individual stages for launch vehicle mate, encapsulated payload integration, and ILV installation onto the transporter erector (TE).

Post-launch, Blue Origin will also provide return transportation of any GSE and associated containers from the launch pad to facilitate packing and shipment activities, as well as return transportation to the airport if required.

8.1.5 Customer Logistics

The Blue Origin team coordinates arrangements to welcome the customer and their payload(s) to Florida. If arriving by air, most payloads and GSE typically fly to the area via charter flight to one of the airports in the region listed in Table 8-2. As necessary, the Customer Integration Director (CID) helps the customer facilitate landing permissions at KSC with the appropriate aviation authorities.

Table 8-2: Airports in the Cape Canaveral area

Airport	FAA Identifier	Latitude / Longitude	Runway Dimensions
Space Coast Regional Airport, Titusville, FL	KTIX	28.5148° N 80.7992° W	2,231 x 46 m (7319 x 150 ft)
NASA Shuttle Landing Facility, KSC	KTTS	28.6149° N 80.6944° W	4,572 x 91 m (15,001 x 300 ft)
Orlando International Airport, Orlando, FL	KMCO	28.4294° N 81.3090° W	3,659 x 61 m (12,005 x 200 ft)

During launch campaigns, Blue Origin recommends that customer personnel arrive via commercial air transport at Orlando International Airport, rent cars, and select hotel accommodations in the Cocoa Beach or Titusville, FL area. Blue Origin does not offer such accommodations as part of standard launch services; however, the CID can provide specific recommendations.

Access to CCAFS property is controlled per current Range security procedures, and all visitors must be badged to gain access to the launch site. Blue Origin manages CCAFS badging on behalf of all customer personnel, as requested, bearing in mind lengthier approval procedures may apply to non-U.S. personnel.



Figure 8-9: Blue Origin headquarters – Kent, WA

8.2 BLUE ORIGIN HEADQUARTERS, WASHINGTON

Blue Origin's primary engineering, research and development site and corporate headquarters is located in Kent, WA, 27 km (17 mi) from downtown Seattle and 10 km (6 mi) from Seattle-Tacoma International Airport. Home to most of Blue Origin's scientists, engineers and technicians, the modern campus features more than 39,000 m² (420,000 ft²) of office, assembly space, machine shops, and software/avionics labs (see Figure 8-9). The facility hosts additional production facilities for BE-4 and BE-3 engines, as well as fabrication of New Shepard crew capsules and propulsion modules. Also on the premises are small-scale rocket motor test stands and secondary launch/mission control facilities. All business and administrative operations are managed from Kent.

8.3 DEVELOPMENTAL ROCKET LAUNCH AND TEST SITE, TEXAS

Blue Origin's large scale energetic test facilities at the West Texas Launch Site (WTLS) reside on nearly 300,000 acres near Van Horn, TX. The site features significant infrastructure for testing BE-3, BE-3U, and BE-4 engines, including a staged-combustion test facility, a pre-burner test facility, and redundant full engine test facilities (see Figure 8-10). WTLS operates near-continuously and has achieved one of the highest rates of engine testing of any such facility in the world. WTLS is also the initial operating and test location for the suborbital New Shepard vehicle system.



Figure 8-10: Developmental rocket launch and test site – Van Horn, TX

8.4 SALES/GOVERNMENT RELATIONS OFFICE, VIRGINIA

The Blue Origin customer and stakeholder interfacing teams are principally located in Arlington, VA. These teams include Sales, Marketing & Customer Experience and Government Sales & Strategy functions.

8.5 SALES OFFICE, PARIS, FRANCE

The Blue Origin Europe, Middle East, and Africa regional office is based in Paris, France. This team includes Sales, Marketing & Customer Experience and Legal & Contracts functions.

Appendix A: ACRONYMS & ABBREVIATIONS

Appendix A ACRONYMS AND ABBREVIATIONS

6DOF	Six Degrees of Freedom
A	Ampere
AIP	Adapter Interface Plane
ASO	Astrotech Space Operations
BTU	British Thermal Unit
CBOD	Clamp Band Opening Device
CCAFS	Cape Canaveral Air Force Station
CCAM	Contamination Collision Avoidance Maneuver
CEO	Chief Executive Officer
CID	Customer Integration Director
CFR	Code of Federal Regulations
CG	Center of Gravity
CLA	Coupled Loads Analysis
COTS	Commercial Off-the-Shelf
CVCM	Collected Volatile Condensable Material
dB	Decibels
dB μ V	Decibels-Microvolt
ECS	Environmental Control Systems
EDC	Effective Date of Contract
EED	Electro-Explosive Device
EELV	Evolved Expendable Launch Vehicle
EGSE	Electrical Ground Support Equipment
EM	Electromagnetic
EMISM	Electromagnetic Interference Safety Margin
EPS	Encapsulated Postscript
FAA	Federal Aviation Administration
FL	Florida
GEO	Geostationary Earth Orbit
GMT	Greenwich Mean Time
GORR	Ground Operations Readiness Review
GOWG	Ground Operations Working Group
GSE	Ground Support Equipment
GTO	Geostationary Transfer Orbit
HEPA	High-Efficiency Particulate Air
HTGSE	Handling and Transportation Ground Support Equipment
Hz	Hertz
ICD	Interface Control Document
IF	Integration Facility

IFD	In-Flight Disconnect
ILV	Integrated Launch Vehicle
IRD	Interface Requirements Document
IRIG	Inter-Range Instrumentation Group
ISO	International Standards Organization
ISS	International Space Station
IT	Information Technology
ITAR	International Traffic in Arms Regulations
kN	Kiloneutron
kVA	Kilovolts-ampere
KSC	Kennedy Space Center
LC	Launch Complex
LCC	Launch Control Center
LEO	Low Earth Orbit
LH ₂	Liquid Hydrogen
LNG	Liquefied Natural Gas
LOX	Liquid Oxygen
LPSS	Low-shock Payload Separation System
LRR	Launch Readiness Review
LSC	Launch Services Contract
LV	Launch Vehicle
LVIP	Launch Vehicle Interface Plane
mA	Milliamp
mΩ	Milliohm
MΩ	Megaohm
MCC	Mission Control Center
MDR	Mission Design Review
MET	Mission Elapsed Time
MECO	Main Engine Cut-Off
MHz	Megahertz
MIL	Military
MRR	Mission Readiness Review
MSPSP	Missile System Pre-launch Safety Package
NASA	National Aeronautics and Space Administration
NSI	NASA Standard Initiator
NVR	Non-Volatile Residue
Pa	Pascals
PAS	Payload Adapter System
PI	Payload Integrator
PLF	Payload Fairing

PPE	Personal Protection Equipment
PPF	Payload Processing Facility
PUG	Payload User's Guide
RAAN	Right Ascension of the Ascending Node
Range	United States Air Force Eastern Test Range
RCS	Reaction Control System
RF	Radio Frequency
SC	Spacecraft
SCAPE	Self-Contained Atmospheric Protective Ensemble
SCIP	Spacecraft Interface Plane
SECO	Second Engine Cut-Off
SEIP	Standard Electrical Interface Panel
SIP	Standard Interface Plane
SIS	Standard Interface Specifications
SOW	Statement of Work
STD	Standard
SVIP	Space Vehicle Interface Panel
T-0	Time-Zero
TAA	Technical Assistance Agreement
TE	Transporter-Erector
TIM	Technical Interchange Meeting
TML	Total Mass Loss
TX	Texas
V	Volts
V&V	Validation and Verification
VA	Virginia
VDC	Volts, Direct Current
VIP	Very Important Person
WA	Washington
WRT	With Respect To
WTLS	West Texas Launch Site

Appendix B: PAYLOAD QUESTIONNAIRE

Appendix B **PAYOUT QUESTIONNAIRE**

INITIAL COMPATIBILITY ASSESSMENT

Customers must provide the following information in the course of integration activities to determine compatibility with the New Glenn launch vehicle. These inputs, which may be delivered in the form of an interface requirements document (IRD), are used to inform the mission ICD. Along with the technical requirements in Table B-1 below, the customer must also provide the following basic mission information:

- o Spacecraft Name
- o Spacecraft Owner
- o Spacecraft Manufacturer
- o Spacecraft Model Number
- o Name of Principal Contact
- o Telephone Number of Principal Contact
- o Date of Submittal
- o Date of Launches
- o Number of Launches

Table B-1: Initial New Glenn payload compatibility questionnaire

Spacecraft Design Parameter	SI Units	English Units
TRAJECTORY REQUIREMENTS		
Spacecraft Mass	kg	lbfm
Operational Spacecraft Lifetime	yr	yr
Final Orbit Apogee	km	nmi
Final Orbit Perigee	km	nmi
Final Orbit Inclination	deg	deg
Propulsion – Propellant Type, Orbit Insertion		
Propulsion – Propellant Type, Stationkeeping		
Propulsion – Propellant Mass	kg	lbfm
Propulsion – Effective Isp	s	s
Maximum Apogee Allowable	km	nmi
Minimum Perigee Allowable	km	nmi
Argument of Perigee Requirement	deg	deg
RAAN Requirement	deg	deg
MECHANICAL INTERFACE		
Spacecraft Effective Diameter	mm	in
Spacecraft Height	mm	in
Spacecraft/Launch Vehicle Interface Diameter	mm	in
Payload Sep System Supplier (SC or LV)		

Spacecraft Design Parameter	SI Units	English Units
Payload Adapter Supplier (SC or LV)		
ELECTRICAL INTERFACE		
Spacecraft Electrical Drawing (Near AIP)		
Number of Launch Vehicle Signals Required		
Number of Separation Discretes Required		
Number of Umbilicals & Pins/Umbilical		
Curve of Spacecraft-Induced Elec. Field Radiated Emissions	dB μ V/m	n/a
Curve of Spacecraft-Radiated Susceptibility	dB μ V/m	n/a
THERMAL ENVIRONMENT		
Pre-launch Internal PLF Ground Transport Temperature Range	°C	°F
Pre-launch Internal PLF Launch Pad Temperature Range	°C	°F
Maximum Pre-launch Gas Impingement Velocity	m/s	ft/s
Maximum Ascent Heat Flux	W/m ²	BTU/hr-ft ²
Maximum Free-Molecular Heat Flux	W/m ³	BTU/hr-ft ³
Maximum Fairing Ascent Depressurization Rate	Pa/s	psi/s
DYNAMIC ENVIRONMENT		
Maximum Allowable Flight Acoustics	dB OA	dB OA
Allowable Acoustics Curve		
Maximum Allowable Sine Vibration	GRMS	GRMS
Allowable Sine Vibration Curve	GRMS	GRMS
Maximum Allowable Shock	g	g
Allowable Shock Curve		
Maximum Acceleration (Static + Dynamic) Lateral	g	g
Maximum Acceleration (Static + Dynamic) Axial	g	g
Minimum Fundamental Natural Frequency – Lateral	Hz	Hz
Minimum Fundamental Natural Frequency – Axial	Hz	Hz
Cg–Thrust Axis (Origin at Separation Plane)	mm	in
CONTAMINATION REQUIREMENTS		
Fairing Air Cleanliness	ISO	Class
Maximum Molecular Deposition on SC Surfaces	Angstroms	n/a
Maximum Particulate Deposition on SC Surfaces	% obscured	% obscured
ORBIT INJECTION CONDITIONS		
Range of Separation Velocity	m/s	ft/s
Max Angular Rate at Separation-Roll	rpm	rpm

Appendix C: DUAL MANIFEST MAXIMUM VOLUME

Appendix C DUAL MANIFEST, MAXIMUM VOLUME

In dual manifest configuration upper berth only, there exists additional volume below the AIP and above into the ogive section of the PLF, pending a dynamic clearance analysis and coupled loads analysis. These maximum volumes are available as part of optional launch services and are detailed below.

The upper berth maximum volume, detailed in Figure C-1, permits antennas, nozzles, or other spacecraft components to hang further below the AIP than in the lower berth due to the absence of PLF vents, which exist only at the base of the PLF and dual manifest structure. Additionally, the available dynamic envelope coincides more closely with the single manifest configuration, being slightly wider in diameter and reaching the maximum ogive height without the constraint of the dual manifest structure. Please contact Blue Origin to determine if use of the maximum volume will meet the payload's requirements.

The dual manifest maximum volume shares an axis of symmetry about the longitudinal (X) axis of the launch vehicle through the center of the AIP, and extends a maximum of 1524 mm (60 in) below the AIP. The ogive portion of the maximum volume extends 2,362.2 mm (93 in) above the dual manifest standard volume.

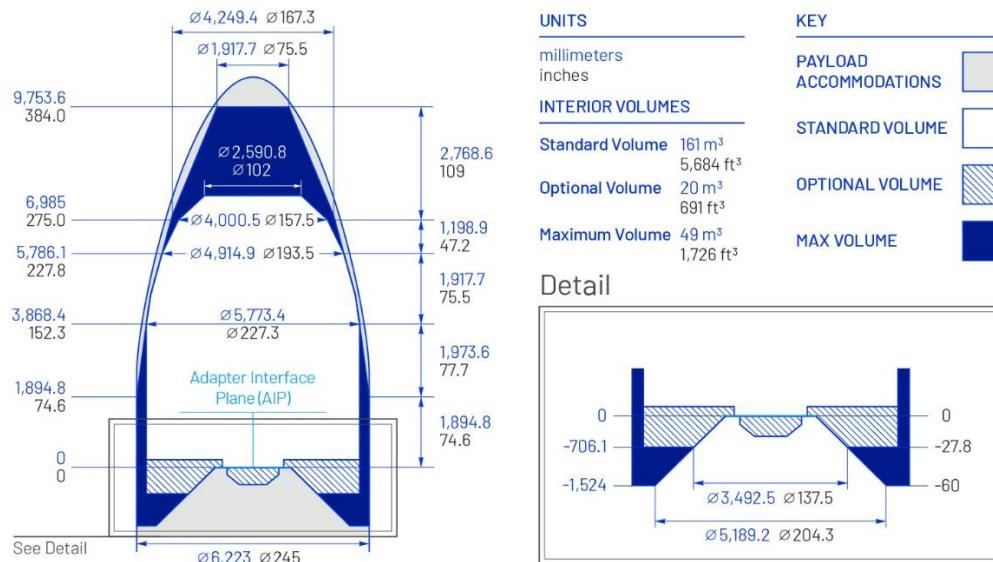


Figure C-1: Detail of dual manifest upper berth maximum volume