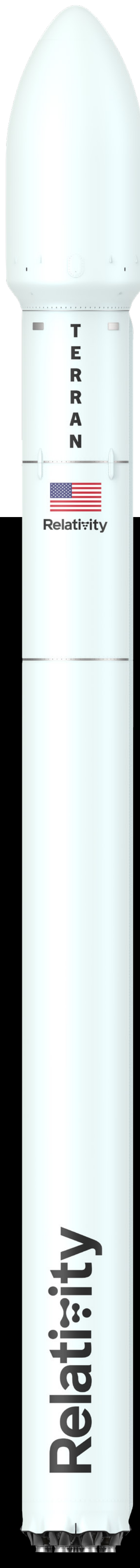

Relativity

TERRAN 1

PAYLOAD USER'S GUIDE

Relativity Space, Inc. | Version 2.0 | August 2020

RELATIVITY SPACE

IS REIMAGINING HOW ROCKETS ARE DESIGNED AND MANUFACTURED TO ENABLE RAPID, RELIABLE, AND AFFORDABLE ACCESS TO SPACE.

WE CREATED THE FIRST AUTONOMOUS ROCKET FACTORY AND LAUNCH SERVICE, TO ALLOW ROCKETS TO BE BUILT AND FLOWN IN DAYS INSTEAD OF YEARS.

THE FUTURE OF HUMANITY IS INTERPLANETARY AND OUR TECHNOLOGY WILL ACELLERATE OUR ABILITY TO BUILD A PERMANENT PRESENCE ON THE MOON, MARS, AND BEYOND WHILE ALSO IMPROVING LIFE ON EARTH.

● PRINTING SINCE 2015

PAYLOAD USER'S GUIDE OVERVIEW

This Payload User's Guide provides generalized information about Relativity Space's launch services using the Terran 1 launch vehicle. Readers should use it for initial planning purposes only. Each launch service includes mission specific interface requirements, engineering analyses, and related verifications that are documented as a part of the interface control document and supersede the information presented herein. This Payload User's Guide does not contain technical data that is subject to export controls under EAR and ITAR.

REVISION HISTORY

Relativity will revise this User's Guide periodically to reflect any updates in the launch service offering, where the latest version can be found at www.relativityspace.com.

DATE	VERSION	HISTORY
December 2018	1.0	Non-Public Release
November 2019	1.1	Non-Public Release
August 2020	2.0	Public Release, Overall Update

CONTACT RELATIVITY

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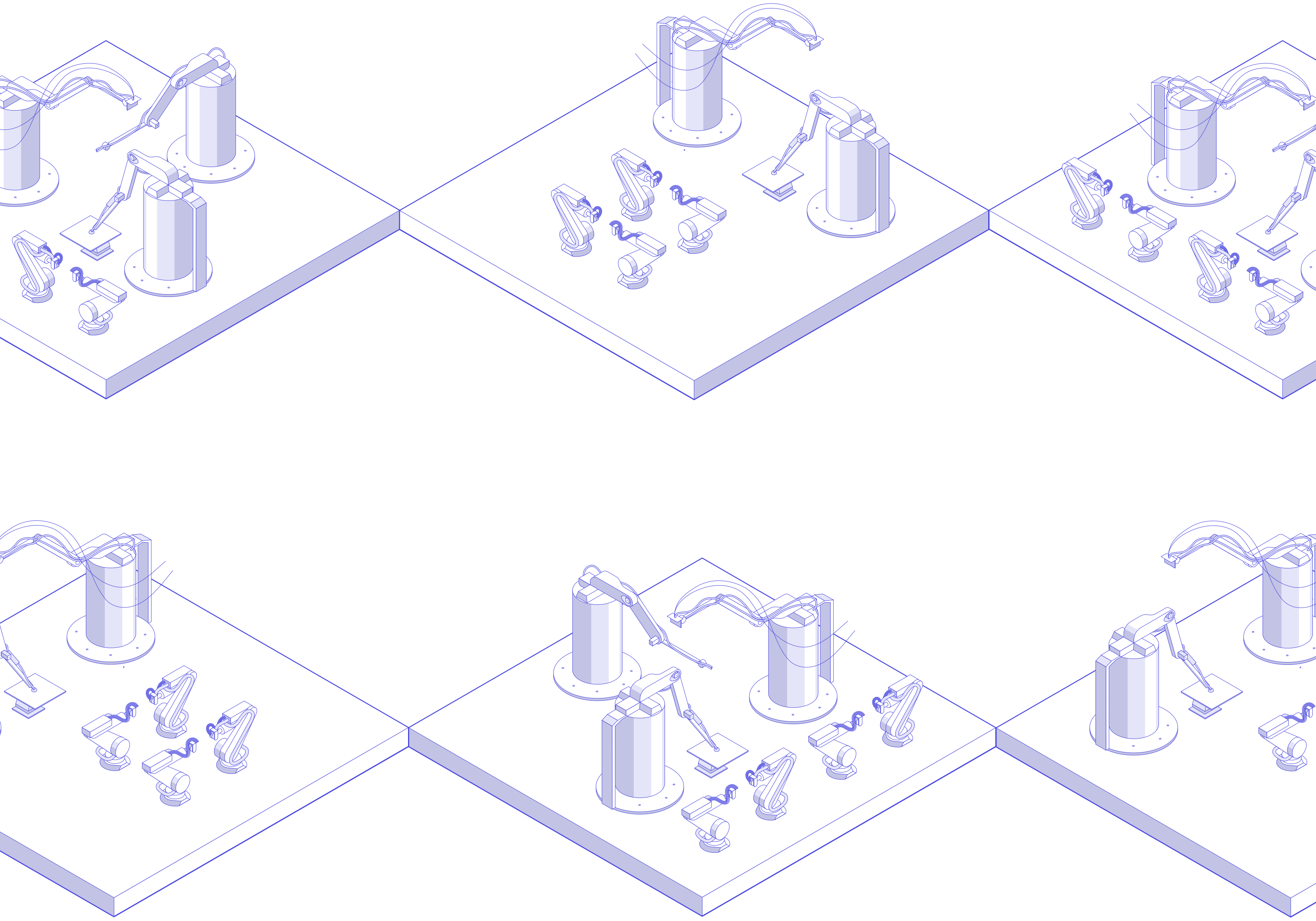

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1.0

RELATIVITY OVERVIEW

RELATIVITY
OVERVIEW

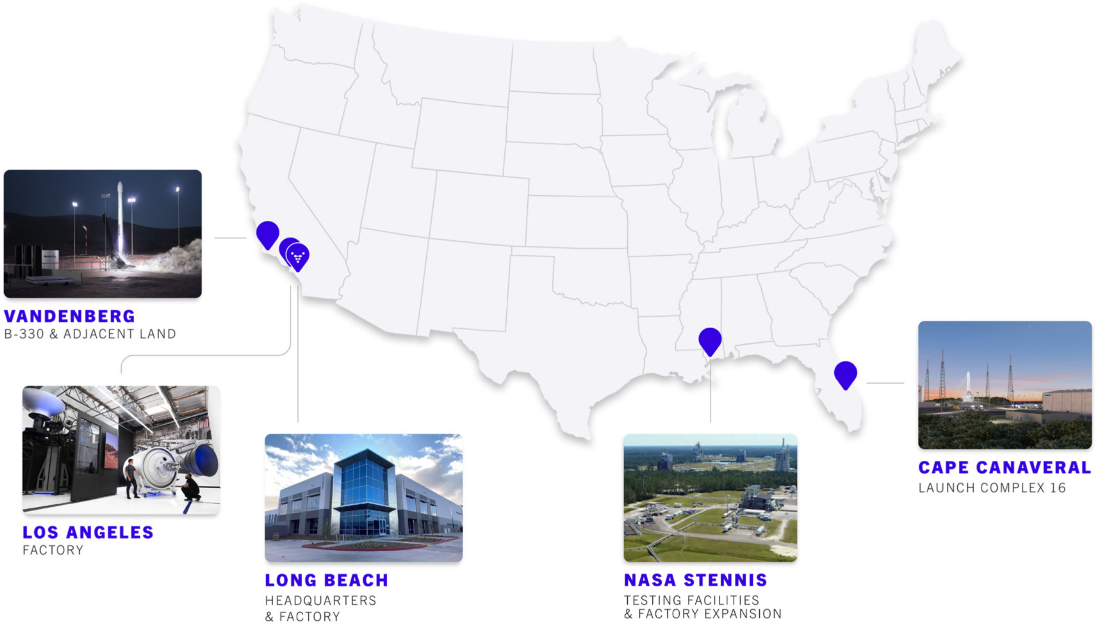
Relativity Space, Inc. (Relativity) offers advanced manufacturing and launch service capabilities that disrupt the economics of space. Our 3D printing platform vertically integrates artificial intelligence, robotics and patented autonomous manufacturing technology to build the world's first entirely 3D printed rocket, Terran 1, from raw material to flight in less than 60 days. As a next-generation space company, Relativity will improve connectivity and security across the planet by inserting satellites into orbit with industry-defining lead time, flexibility, and cost.

Terran 1 is entirely designed, built, and flown by Relativity in American-based facilities (FIGURE 1), and offers a 3-meter fairing with a mass-to-orbit capability of up to 1,500 kg to low Earth orbit for dedicated, multi-manifest, and rideshare missions. Terran 1 is able to serve a wide range of inclinations from our launch sites at Cape Canaveral Air Force Station and Vandenberg Air Force Base. Relativity offers custom, 3D printed payload adapter solutions using the same design, production, and test capabilities as are used for the Terran 1 vehicle itself. Relativity's design and production approach offers increased reliability thanks to fewer parts than traditional rockets which enables accelerated production rates while also significantly reducing opportunities for human error in the assembly process. Relativity is establishing a new standard for quality, speed, and cost in aerospace production. Our engineering and production teams are tightly coupled for continuous improvement in quality and printing capabilities.

Relativity offers Terran 1 launch services using the industry's most straightforward and transparent mission integration process focused on mission success. Our team has 400+ combined years of experience building spaceflight hardware, automating systems, and 3D printing and has collectively executed more than 140 successful flights. Relativity's headquarters is located in Long Beach, California, and houses our primary manufacturing facilities and design center. We also operate state-of-the-art propulsion test facilities at the National Aeronautics and Space Administration (NASA) Stennis Space Center and launch sites in Florida and California. By choosing Relativity for launch services, you put your trust in a competent launch service provider focused on best-in-class customer experience, while also working side by side with a company dedicated to rapidly advancing the state of aerospace manufacturing. Please contact us to discuss mission-specific services and pricing at launch@relativityspace.com.

Relativity was founded in 2015 and is privately funded and US-owned, where our investors include Bond, Tribe, Playground, Y Combinator Continuity, Social Capital, and Mark Cuban, with additional support from Phil Spector, Stanford, and the University of Southern California.

FIGURE 1 | **Relativity Space Manufacturing and Operations Facility Locations**



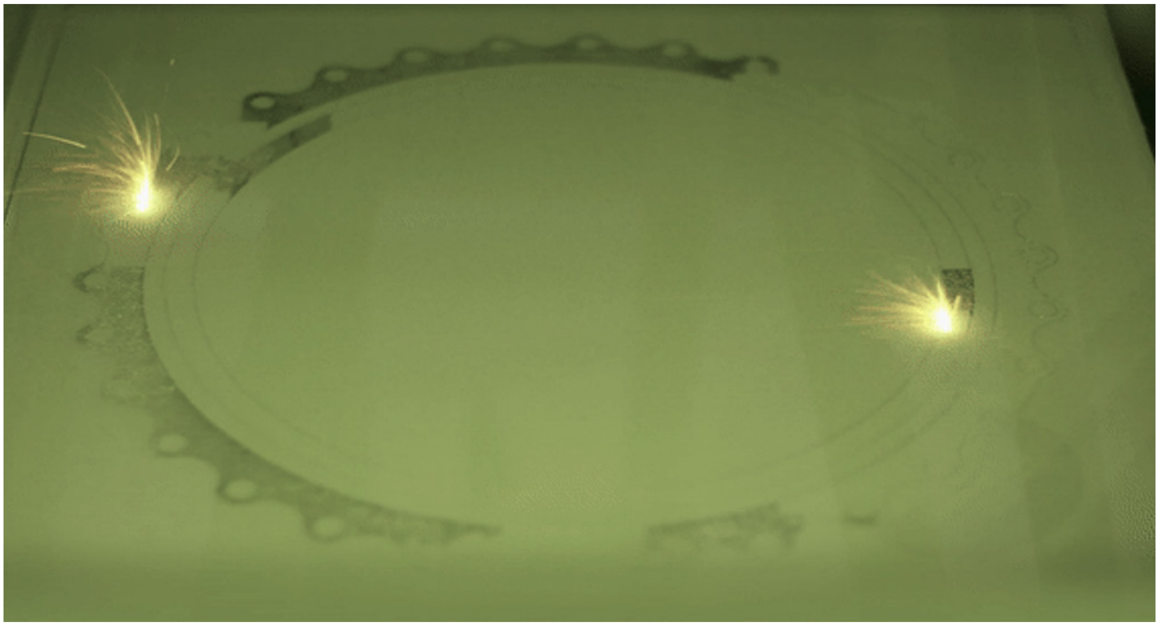
1.1 | ADVANCED AEROSPACE MANUFACTURING

Relativity utilizes two types of 3D printing to produce over 90% of the dry mass of Terran 1. Relativity's large format, proprietary 3D printing process, known as Stargate (FIGURE 2), is used to produce primary and secondary structures for Terran 1 from a proprietary aluminum alloy – with printing, inspection, and the little post-processing required occurring all in a single print cell. Stargate can currently print structures up to 3.4 meters (11 feet) diameter by 7.6 meters (25 feet) tall—the world's largest metallic printed parts. Relativity uses direct-to-metal laser sintering (DMLS) to produce geometrically small, high fidelity components for Terran 1 (FIGURE 3). Each Stargate printer includes real time in-situ monitoring, inspection, and post-processing capabilities, which take place layer-by-layer rather than post-print. Video, audio, and thermal sensors enable closed-loop control and in process inspection to mitigate flaw formation. Computer vision and machine learning bring state-of-the-art control techniques to a highly nonlinear, highly coupled process. Relativity evaluates coupons from each print (Stargate prints and DMLS) for traceability, and uses in-house materials and processing capabilities for inspection and characterization of mechanical properties (e.g. microstructure, hardness testing, microscopy).

Through this approach, our technology immediately identifies, characterizes, and adapts to any print anomalies, resulting in fully verifiable printed products. The result is the world's first evolvable aerospace production line using data-driven learning to track and improve every aspect of rocket manufacturing. By fully leveraging 3D printing techniques, Relativity's team greatly simplifies the supply chain, reduces part count by 100x across Terran 1's structure and engines, significantly reduces lead times and overhead, and increases overall vehicle system reliability.

FIGURE 2 | **Stargate Large Format Metal 3D Printing System**

FIGURE 3 | **Direct-to-metal Laser Sintering (DMLS) Print**



2.0

TERRAN 1
OVERVIEW

TERRAN 1
OVERVIEW

Terran 1 is an expendable two-stage launch vehicle powered by liquid natural gas (LNG) and liquid oxygen (LOX). Relativity designs, builds, and operates Terran 1 to provide customers the most responsive and affordable small satellite launch service on the market.

The Terran 1 vehicle is 35 m (115 ft) in height by 2.3 m (7.5 ft) in diameter and uses 10 Aeon engines: nine Aeon-1 engines on the first stage, and one Aeon Vacuum engine on the second stage. We print all structures and major engine components using proprietary printable metal alloys, which leads to a dramatically simplified manufacturing process when compared to traditional fabrication methods. This will make it possible to shrink vehicle build and integration timelines down to just 60 days. The payload fairing leads its class in volume at 3 m (10 ft) diameter x 6.8 m (22.2 ft) with a 986 mm (38.81 in) standard payload interface. Terran 1's fairing volume accommodates a variety of payload designs and configurations, including dedicated launch for single payloads and constellations as well as multi-manifest and rideshare configurations. Terran 1 is designed for a mission duration of up to 2.5 hours as a standard service.

The design of Terran 1 provides a predictable and controlled launch environment allowing for simplified payload design requirements. Terran 1 can support both industry-standard and custom interfaces, using commercially available adapter and separation hardware in addition to mission-specific designs. Environmental control systems maintain clean, thermally controlled payload environments.

Terran 1 has a single-string avionics system designed using a combination of flight-proven, off-the-shelf components and in-house designs. The avionics system includes, but is not limited to, a flight computer, global positioning system (GPS), inertial measurement unit (IMU), telemetry processor, custom data acquisition and vehicle control processors, high speed sensor suite, batteries, and cameras. The avionics suite is duplicated on the test bench with a full hardware-in-the-loop (HITL) system to simulate full missions in order to exercise hardware, software, and algorithm performance in a test-like-you-fly environment. We develop ground and flight software in-house and thoroughly exercise it using HITL tests prior to deployment to a flight vehicle.

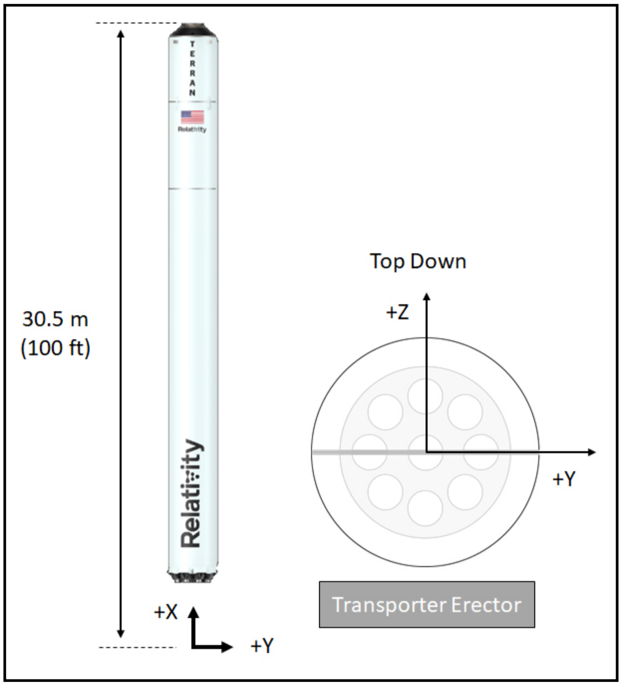
To maximize flexibility, the avionics system includes a bussed, modular infrastructure that makes it possible to rapidly add or subtract components to meet changing vehicle configurations. We designed the avionics system to leverage component and architecture commonality across both stages in order to reduce development time and simplify vehicle operations. We designed vehicle components to be as accessible as possible, allowing for us to quickly and unobtrusively make any necessary modifications late in the integration process. Our engineering team is considering vehicle reusability in our development roadmap and is making allocations in the current design for a fluid upgrade transition to reusability.

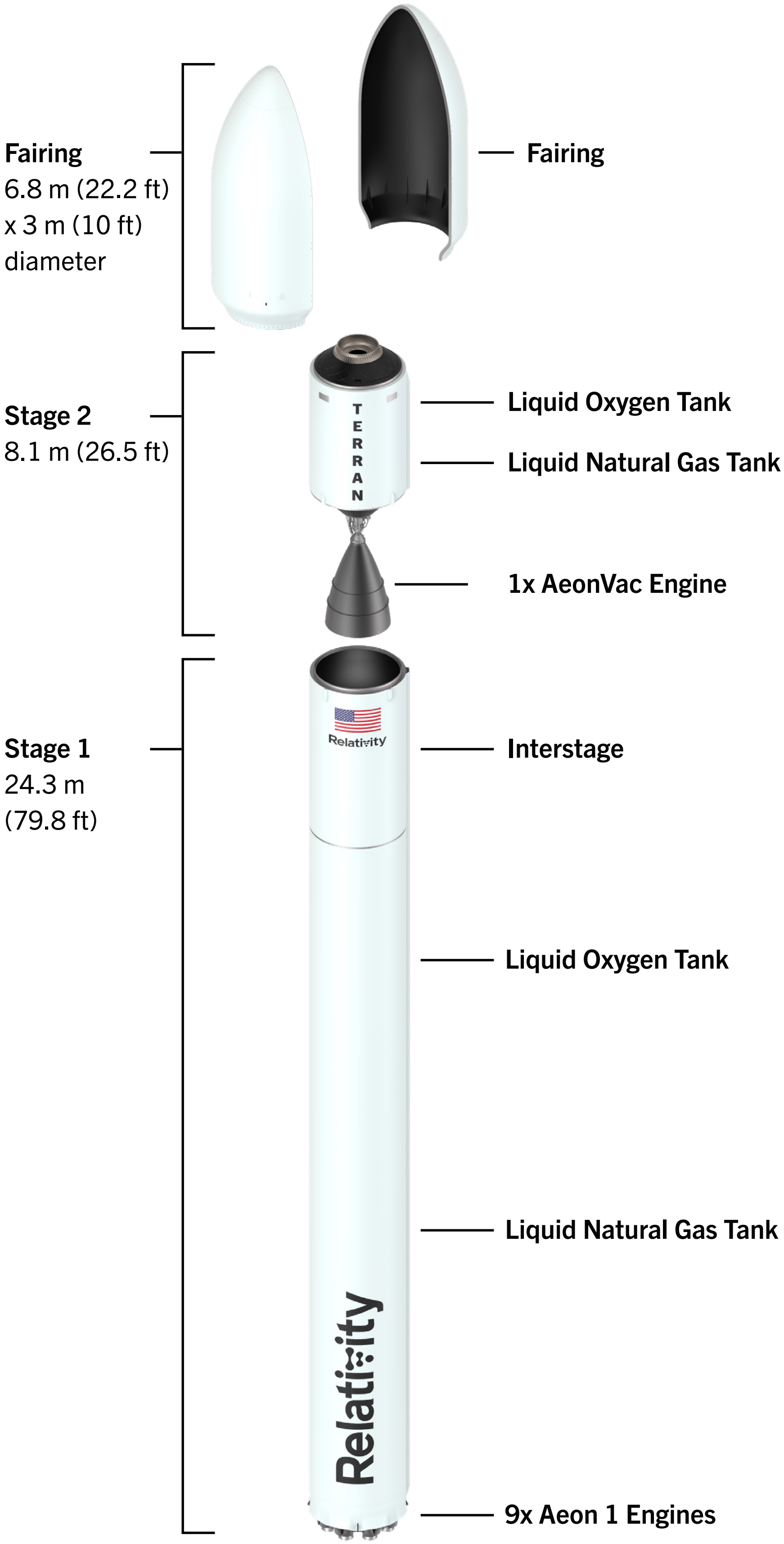
An autonomous flight termination unit (AFTU) provides safety in-flight by monitoring the flight path throughout ascent and issuing a thrust termination command in the event of anomaly. The autonomous flight safety system (AFSS), which includes this AFTU, is qualified to both US Air Force Range Safety and FAA Office of Commercial Space Transportation requirements. In addition, operational safety on the ground is provided by the inclusion of a hazard power bus and other lockout controls which must be actuated on the ground, independent of vehicle avionics control. Component selection prioritizes inclusion of features that prevent incorrect installation, minimize shock and shorting risks, and have been tested to a range of dynamic and thermal environments.

2.1 | COORDINATE FRAME

The launch vehicle coordinate reference frame originates at a point 100 ft aft of the standard payload attach fitting interface, along the longitudinal axis of the vehicle (FIGURE 4). Terran 1 uses a right-handed XYZ coordinate system, where the +X axis is aligned with the vehicle long axis pointing in the direction of flight. The +Z axis points opposite of the transporter erector. The +Y axis completes the right-handed set and is parallel to the fairing seam. The +X axis is considered the "roll" axis, +Y is the "pitch" axis and +Z is the "yaw" axis.

FIGURE 4 | **Terran 1 Coordinate Frame**





Stage 2

- 1x AeonVac engine (28,300 lbf in vacuum)
- Engine restart capability
- Autogenously pressurized
- Integrally printed tanks with a common dome
- Cold-gas reaction control system
- Metallic fairing with pneumatic separation system
- Autonomous flight termination units

Stage 1

- 9x Aeon-1 engines (23,000 lbf at sea level each)
- Autogenously pressurized
- Integrally printed tanks with a common dome
- Printed interstage with stage separation system including pneumatic pushers
- Autonomous flight safety system

Aeon 1 and AeonVac

- Gas generator engine cycle
- Gas-gas torch igniter
- Electric thrust vector control

Structures

- Proprietary printable aluminum alloy

Propellants

- Oxygen and Liquid Natural Gas (~97% methane)

TERRAN 1

2.2 | STAGE 1

The Terran 1 first stage assembly consists of three main components: the thrust structure, the Stage 1 tank, and the interstage. The tanks share a common dome and airframe that is integrally printed as monolithic sections, where a horizontal welding process integrates Stage 1 segments together to achieve the final stage structure. A transfer tube carries LOX through the center of the LNG tank to the engines. Nine Aeon-1 engines power the first stage with up to 23,000 lbf thrust per engine at sea level, for a total thrust of up to 207,000 lbf at liftoff.

Terran 1 autogeneously pressurizes the tanks with gaseous natural gas and gaseous oxygen via heat exchangers integrated into the Aeon-1 engines, eliminating the need for a separate pressurization system and avoiding the use of helium on the vehicle entirely. Electro-mechanical actuators gimbal the outer 8 engines, providing thrust vector control. The stage separation system is located at the forward end of the interstage and interfaces with the second stage.

2.3 | STAGE 2

The Terran 1 second stage consists of a monolithic printed tank with integral common dome, payload attach fitting, and separable fairing. A single Aeon Vacuum engine powers the second stage with up to 28,300 lbf-vac using a fixed 165:1 expansion nozzle and is capable of multiple restarts including provisions for a deorbit burn. Similar to Stage 1, a heat exchanger on the AeonVac engine generates gaseous natural gas and gaseous oxygen that pressurize their respective tanks autogeneously. Stage 2's payload controller offers separation initiation, separation detection, ethernet and serial in-flight payload telemetry channels. Pitch and yaw control is provided by electro-mechanical thrust vector control actuators affixed to the Aeon Vacuum engine. Roll control and pointing are performed using cold nitrogen gas reaction control thrusters located near the aft end.

2.4 | AEON ENGINES

Relativity's Aeon engines are designed, assembled and tested in house. Except for the second-stage nozzle extension, each of Terran 1's 10 engines is based on a common design—enabling simplified and repeatable manufacturing and acceptance testing. Aeon engines are fueled by liquid natural gas and liquid oxygen and operate using the gas generator engine cycle. Each engine uses two turbopump assemblies for thrust and mixture ratio control: one for liquid natural gas and one for liquid oxygen. The thrust chamber is regeneratively cooled with liquid natural gas, which is then injected into the main combustion chamber and burned with liquid oxygen to produce the required thrust.

2.5 | PAYLOAD MODULE

The payload module consists of the payload attach fitting, payload, and fairing as an assembly. The 3-meter payload fairing is a metallic, 2-piece clamshell design with a frangible axial seam, a tongue-in-groove radial joint at the base, pneumatic pushers to separate and acoustic mitigation provided by acoustic blankets. The payload attach fitting is equipped a 986 mm (38.8 in) payload interface and comes standard with a camera for views of payload separation on orbit. Payload integration and encapsulation occur in the vertical orientation followed by break over to horizontal to mate to Stage 2. While there is no payload access available following encapsulation as a part of the standard launch service, the Terran 1 payload module is designed to accommodate de-encapsulation in the case of launch delay or payload anomaly.

2.6 | TERRAN 1 LAUNCH SERVICES

Relativity's Terran 1 launch service is designed to support foreign and domestic government and commercial satellite customers in launching their spacecraft to orbit. Standard launch services include program management, requirements management and verification, mission assurance and quality management practices, while also incorporating mission specific nonstandard services as required. Whether your program requires unique payload accommodation, payload processing, program insight, or otherwise, Relativity's team provides custom services inside a proven mission execution framework so you can focus on your mission. TABLE 1 summarizes standard and nonstandard services available, where further detail is available upon request.

TABLE 1 | Launch Services Summary

STANDARD SERVICES	NONSTANDARD SERVICES (below are examples, as this list is not exhaustive)
Launch of payload(s) into customer-specified orbit with 986 mm (38.81 in) separation system	Fairing access doors
Dedicated mission manager	Custom insight and reporting requirements
Class 100,000 cleanroom, overhead crane, and fueling support in payload processing facilities	Additional payload separation initiation, detection, and/or data channels
Mission unique design analyses	Instantaneous launch window
One flight set of electrical connectors	Relativity-provided separation system for tests
Interface requirement management	Rapid response launch with short call up time
Customer office space near payload processing facilities	Relativity-provided mass simulator
Conditioned payload environment following encapsulation through time of launch	Custom payload adapter
Collision avoidance analysis and maneuver(s)	Extended mission duration (beyond 2.5 hours)
Post-flight analysis, including environments, and final orbit confirmation	Multiple orbit insertions per launch
Payload umbilical for charge and monitoring	Transportation, logistics, and fueling services

3.0

FACILITIES

FACILITIES

RELATIVITY HEADQUARTERS

Relativity's headquarters is located in Long Beach, California, just south of Long Beach International Airport and the I-405 freeway. Our headquarters span 10,405 m^2 (120,000 square feet), and house our design, manufacturing, research and development, and operations teams which are capable of producing more than (12) Terran 1 vehicles per year.

NASA STENNIS VEHICLE TEST SITES AND FACTORY

Relativity operates one third of the test facilities at NASA Stennis Space Center across the E2, E3, and E4 test sites (FIGURE 5). The E2 site is used for Aeon engine component testing including extensive thrust chamber assembly firings. Since 2016, the E3 test site has been our home for high-pressure and flow rate Aeon-1 engine testing, and has more recently been focused on igniter and gas generator testing. The E4 test site, consisting of four test cells over 89,000 m^2 (22 acres), hosts production testing of Aeon engines along with Terran stage tests. In addition to the test sites, Relativity uses nearby Building 9101 as expansion for production capabilities with the 20,440 m^2 (220,000 square feet) footprint including with 25 meter (80 ft) high bay and bridge cranes.

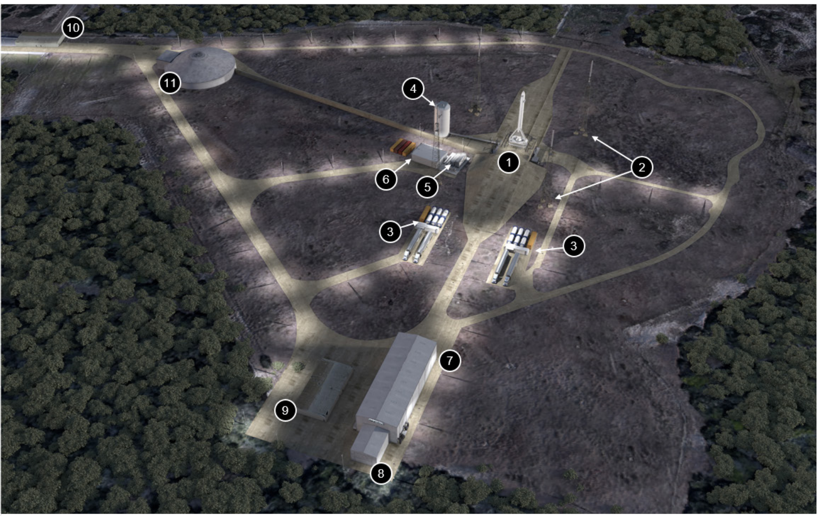
FIGURE 5 | **NASA Stennis Vehicle Test Sites and Factory**

LAUNCH COMPLEX 16

Relativity is constructing a launch facility on site LC-16 at Cape Canaveral Air Force Station (CCAFS) that will support initial test flights of Terran 1 and subsequent customer flights (FIGURE 6). The launch site, on the eastern end of CCAFS at 28°30'6.12" N, 80°33'6.48" W, is ideal for supporting low- to mid-inclination (28.5° to 55°) orbits. Inclinations less than 28° and greater than 55° are also possible but may result in decreased mass to orbit performance due to dogleg

FIGURE 6 | **Launch Complex 16**

LC-16 Infrastructure
1. Launch Pad
2. Lighting Protection System (LPS)
3. Propellant Storage Farms
4. Water Tank
5. High Pressure Gas Storage Area
6. ECS & Pad Support Building
7. Integration Hangar
8. Payload Processing Facility (PPF)
9. Engineering Support Bldg. / Offices
10. Logistics
11. Additional Support Facility



trajectories. Before Relativity was competitively awarded the site in 2019, LC-16 was used by the US Air Force for Titan I, Titan II, and Pershing missile launches, and briefly by NASA for Gemini crew processing and static test firing of the Apollo Service Module's propulsion engine.

SITE B330

Relativity is planning a development of Site B330 at Vandenberg Air Force Base (VAFB) in California to support high-inclination (greater than 66°) flights of Terran 1 (FIGURE 7). The launch site is located on the southern end of VAFB's south base at 34°34'23.1"N 120°37'52.1"W. Before Relativity's activity began in 2020, the B330 site was used by the US Air Force and NASA for solid rocket storage.

FIGURE 7 | **B330 Launch Site Illustration**

4.0

PERFORMANCE
CAPABILITY

PERFORMANCE CAPABILITY

Terran 1 provides direct-injection and multi-burn launch services to a variety of target orbits, delivering as much as 1,500 kg into orbit. Relativity selects which launch site supports each mission based on customer-specified orbit requirements. Terran 1 is built for high injection accuracy, and our standard mission design includes trajectory and separation analyses as well as collision avoidance maneuvers and deorbit as required. Typical circular mission design includes four burns: Stage 1 burn through main engine cutoff; Stage 2 burn through stage engine cutoff followed by a coast to apogee; Stage 2 burn to circularize; and Stage 2 burn to deorbit.

FIGURE 8 and TABLE 2 show payload delivery performance to circular orbits at example inclinations for the Terran 1 vehicle; payload mass represents all flight hardware attached to the payload attach fitting.

FIGURE 8 | **Terran 1 Payload Performance to Circular Orbits**

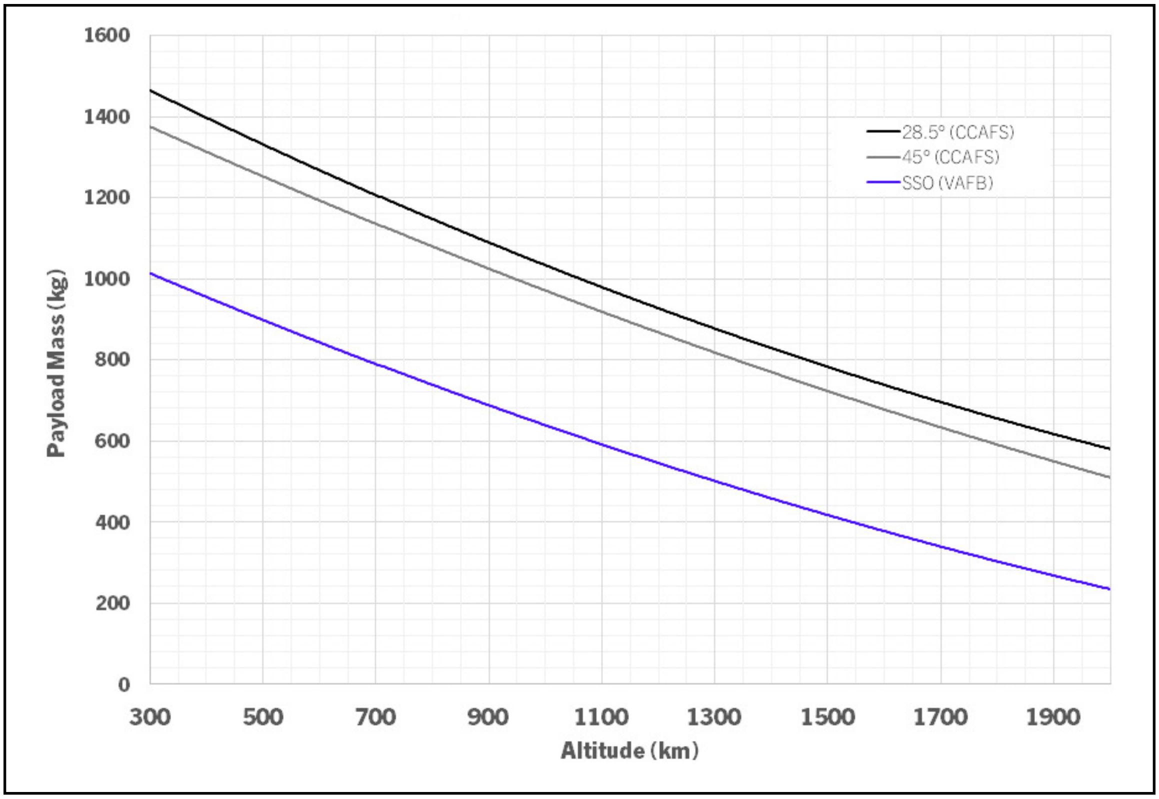


TABLE 2 | **Terran 1 Payload Performance to Circular Insertions (values in kg)**

	INCLINATION (LAUNCH SITE)		
CIRCULAR ALTITUDE TARGET (KM)	**28.5° (CCAFS)**	**45° (CCAFS)**	**SSO (VAFB)**
300	1479	1380	1014
400	1388	1316	956
500	1325	1254	898
600	1276	1193	843
700	1206	1135	790
800	1146	1078	737
900	1090	1021	688
1000	1011	944	640
1100	961	919	593
1200	934	869	527
1300	886	821	505
1400	839	774	462
1500	793	728	417
1600	745	683	380
1700	698	641	342
1800	642	598	304
1900	616	546	267
2000	576	496	231

Terran 1 is also capable of delivering payloads into elliptical orbits as shown in FIGURE 9 and TABLE 3. Please contact Relativity at launch@relativityspace.com for mission specific performance information including the potential use of Terran 1 in combination with our in-space transportation partners for insertions beyond the dropoffs shown.

FIGURE 9 | **Terran 1 Payload Performance to Non-circular Insertions (perigee = 300 km)**

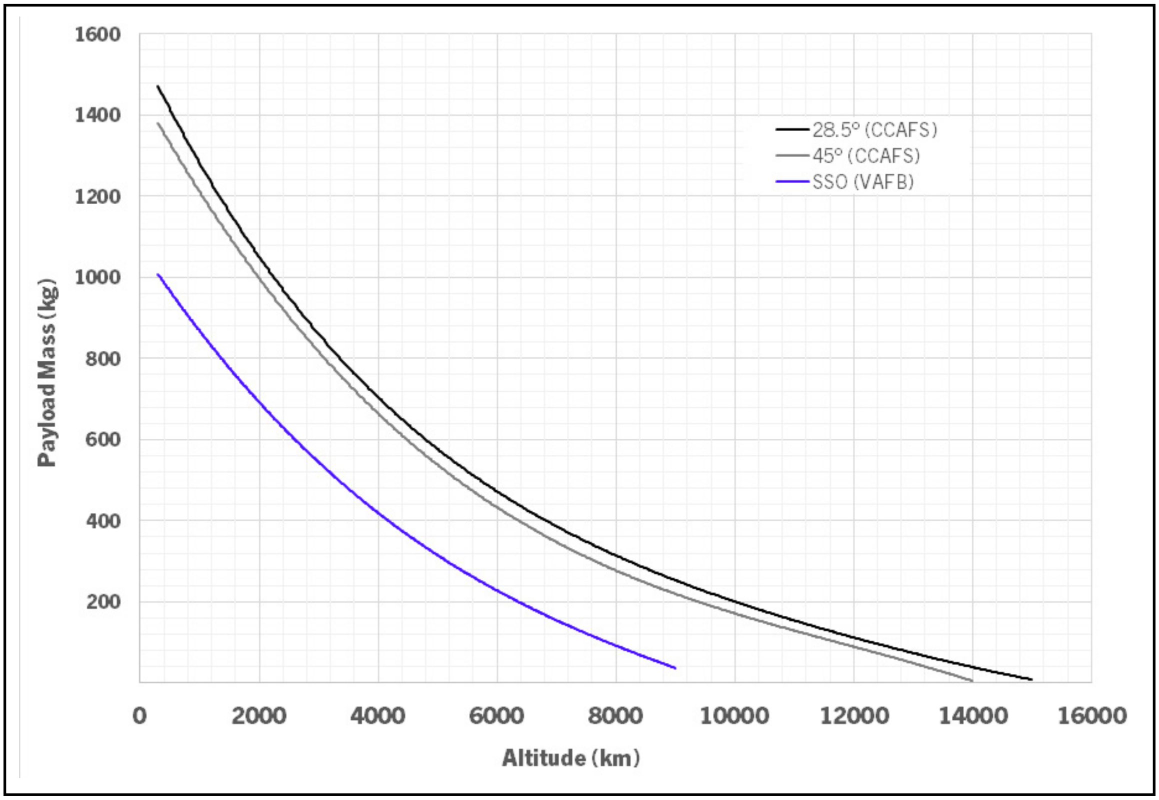


TABLE 3 | **Terran 1 Payload Performance to Non-circular Insertions (perigee = 300 km, values in kg)**

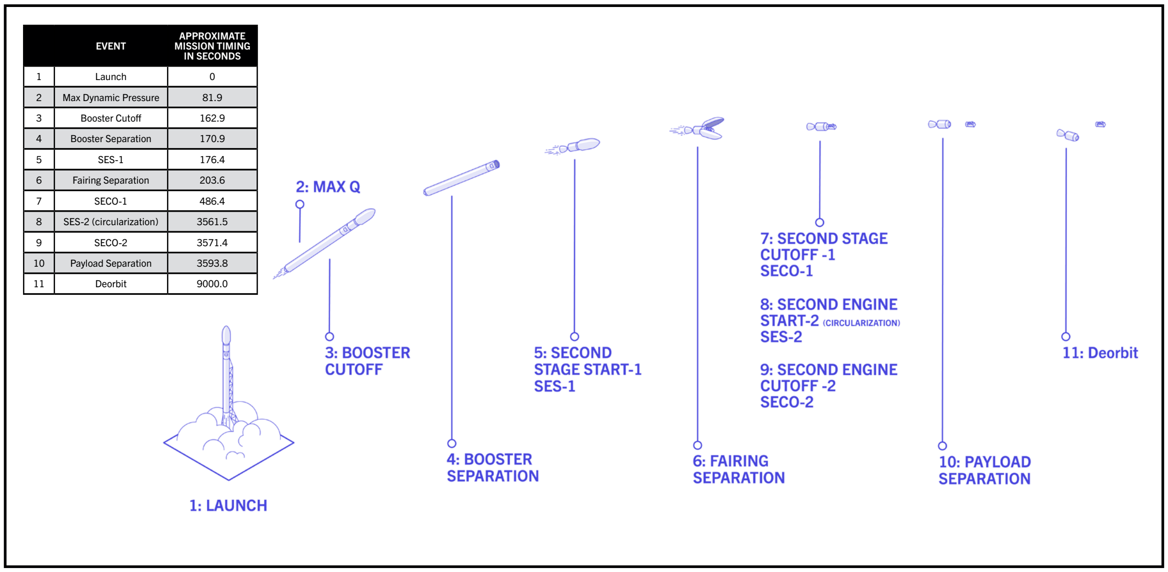
	INCLINATION (LAUNCH SITE)		
APOGEE TARGET (KM)	**28.5° (CCAFS)**	**45° (CCAFS)**	**SSO (VAFB)**
300	1479	1380	1014
400	1441	1354	991
500	1402	1329	967
600	1377	1305	946
700	1352	1281	925
800	1329	1257	903
900	1306	1233	883
1000	1283	1210	864
1100	1261	1189	845
1200	1240	1168	827
1300	1219	1148	809
1400	1198	1128	792
1500	1168	1109	775
1600	1141	1085	759
1700	1115	1060	743

APOGEE TARGET (KM)	28.5° (CCAFS)	45° (CCAFS)	SSO (VAFB)
1800	1091	1036	727
1900	1067	1013	711
2000	1044	991	696
3000	850	804	551
4000	698	656	419
5000	576	537	314
6000	474	438	227
7000	389	355	154
8000	317	284	92
9000	255	223	38
10000	201	170	-
11000	153	124	-
12000	111	82	-
13000	73	46	-
14000	40	13	-
15000	9	-	-

4.1 | EXAMPLE MISSION PROFILE

The example mission profile shown in FIGURE 10 is for delivery of a 900 kg payload to a circular 500 km sun-synchronous orbit from our B330 launch site.

FIGURE 10 | **Standard Mission Profile with Mission Event Timing**



	EVENT	APPROXIMATE MISSION TIMING IN SECONDS
1	Launch	0
2	Max Dynamic Pressure	81.9
3	Booster Cutoff	162.9
4	Booster Separation	170.9
5	SES-1	176.4
6	Fairing Separation	203.6
7	SECO-1	486.4
8	SES-2 (circularization)	3561.5
9	SECO-2	3571.4
10	Payload Separation	3593.8
11	Deorbit	9000.0

4.2 | INJECTION ACCURACY

Terran 1 is designed to meet the 3-sigma injection accuracies for a standard mission as listed in TABLE 4. Mission-specific accuracy predictions are included in the standard launch service.

On day of launch, Relativity standard service includes two launch attempts within a four hour window. The RAAN accuracy estimates in TABLE 4 are for an instantaneous launch window, a nonstandard service.

TABLE 4 | Typical Mission Orbit Insertion Accuracy

Altitude	± 15 km
Inclination	± 0.1°
Right Ascension of Ascending Node (RAAN)	± 0.2°

4.3 | PRE-SEPARATION STAGE ORIENTATION AND BODY RATES

Before payload separation, Stage 2's guidance, navigation, and control system orients itself and the payload to the customer-defined attitude and separation conditions. Stage 2 controls three-axis pointing and pre-separation spin stabilization to within 1 degree/second/axis as required by mission design.

To meet Federal Aviation Administration (FAA) deorbit guidelines, Terran 1 reserves propellant to perform collision avoidance and orbit-lowering burns following payload separation as required by mission-specific trajectories.

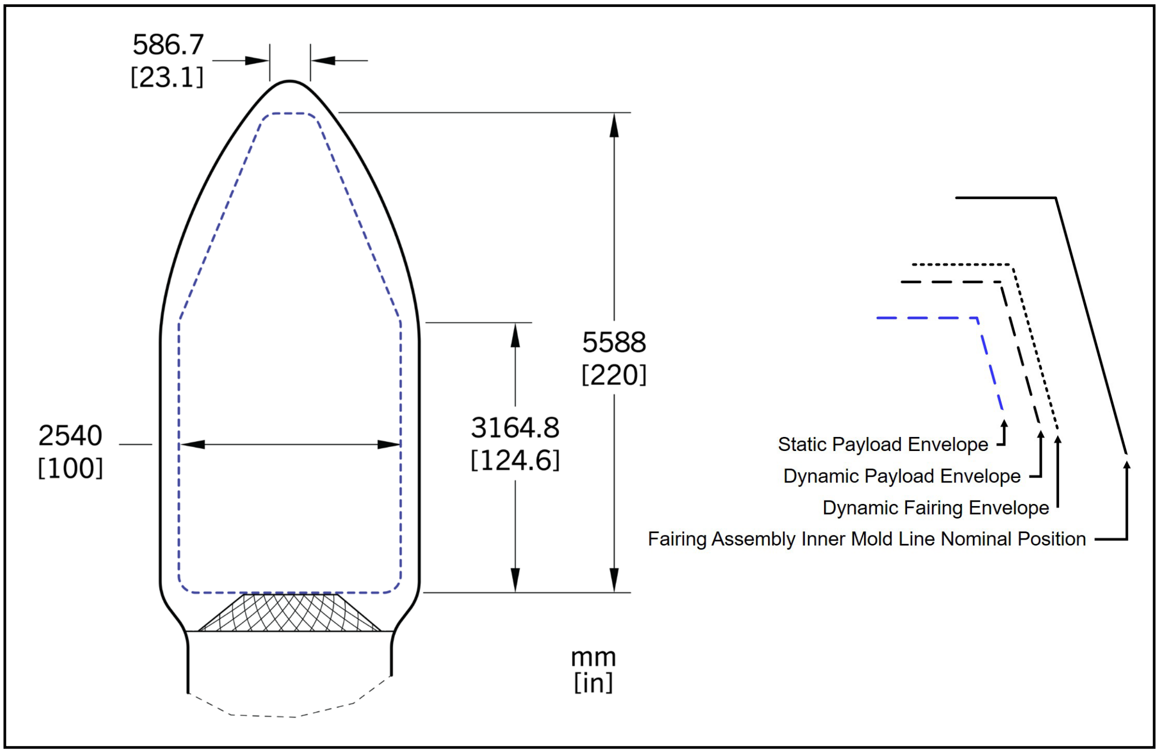
5.0

PAYLOAD INTERFACES

PAYLOAD INTERFACES

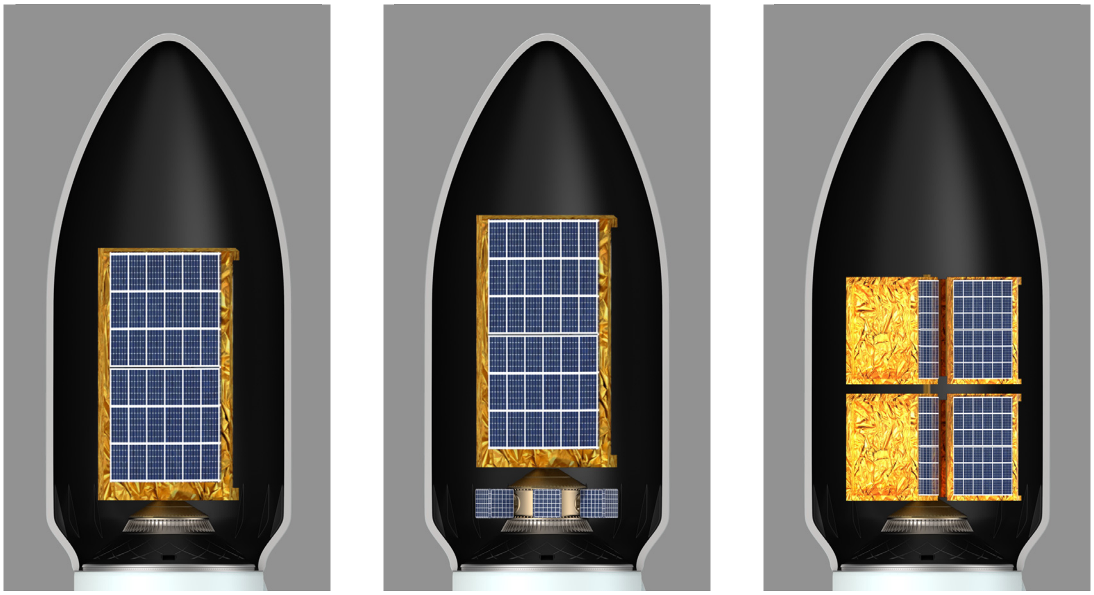
Terran 1 accommodates dedicated, multi-manifest, and rideshare payload configurations in the 2.5 m (100 in) diameter payload envelope as shown in FIGURE 11. The fairing design maintains a minimum of 25.4 mm (1 in) clearance between the fairing dynamic envelope and the payload dynamic envelope, taking into account manufacturing tolerances and all static and dynamic events through fairing separation as shown in FIGURE 11.

FIGURE 11 | **Terran 1 Static Payload Envelope with Clearance Definition**



Terran 1 launch configurations incorporate commercially available payload accommodation structures as well as Relativity-developed structures to optimize the number of payload interfaces and fully utilize lift capacity on each launch. Payloads on dedicated launches typically interface with the standard payload attach fitting either directly with a separation system or a payload adapter. For missions with primary and secondary payloads, secondary adapters are typically attached to the payload attach fitting with the primary payload mounted in the forward position. The generous fairing volume permits a multitude of mission configurations, seen in FIGURE 12, to accommodate a wide variety of payload volumes and masses including ESPA class and larger.

FIGURE 12 | **Example Payload Launch Configurations**



Single Primary Payload

Primary and Rideshare Payloads Mounted to Custom Adapter

Multi-manifest Payloads

5.1 | MECHANICAL INTERFACES

Terran 1's standard payload attach fitting is a 3D printed metallic structure that serves as the mechanical interface between the second stage and the payload module. The standard payload attach fitting interface diameter is 985.8 mm (38.81 in) with 60 thru holes for ¼" fasteners as shown in FIGURE 13 and TABLE 5. Larger bolted interfaces up to 1575 mm (62 in) diameter and custom adapters to smaller and/or non-circular bolted interfaces are available as a part of our nonstandard services, and may result in a modified cylindrical height of the payload envelope.

FIGURE 13 | **Standard Payload Attach Fitting Mechanical Interface**

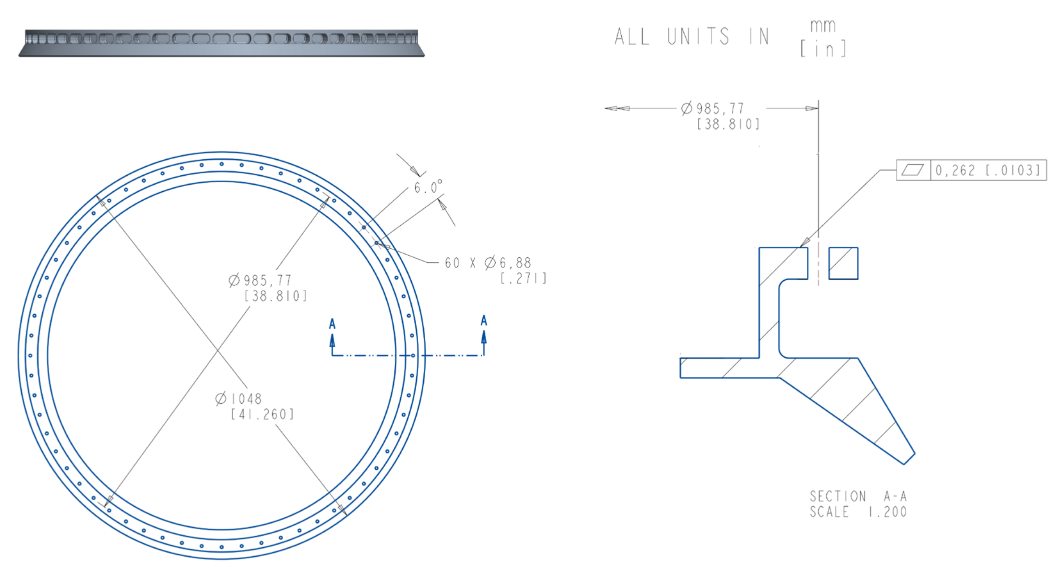


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TABLE 5 | **Standard Payload Attach Fitting Interface Definition**

FEATURE	VALUE	UNITS
Diameter of bolt circle	985.77 [38.81]	mm [in]
Bolt circle diameter tolerance	0.254 [± 0.01]	mm [in]
Flatness	0.2616 [0.0103]	mm [in]
Standard Fastener Size	¼	in
Number of fasteners	60	-

5.2 | ELECTRICAL INTERFACES

Terran 1 avionics suite is designed to accommodate interfaces and separation signal characteristics required by commercially available separation systems and CubeSat dispensers, including Planetary System Corporation's Motorized Lightbands, NASA Standard Initiators (NSIs), Ruag PAS separation systems, and NEA hold down and release mechanisms. Custom separation system interfaces can be supported as a nonstandard service.

PAYLOAD LAUNCH CONFIGURATION ELECTRICAL INTERFACES

Terran 1 launch services include a single flight set of Terran 1- and Payload- side electrical connectors and harnesses incorporating customer-defined umbilical pinout. Relativity recommends customer selection of payload electrical connector types to align with separation system type where appropriate. FIGURE 14 and FIGURE 15 provide an overview of the launch configuration electrical interfaces.

FIGURE 14 | **Launch Configuration Electrical Interface Schematic**

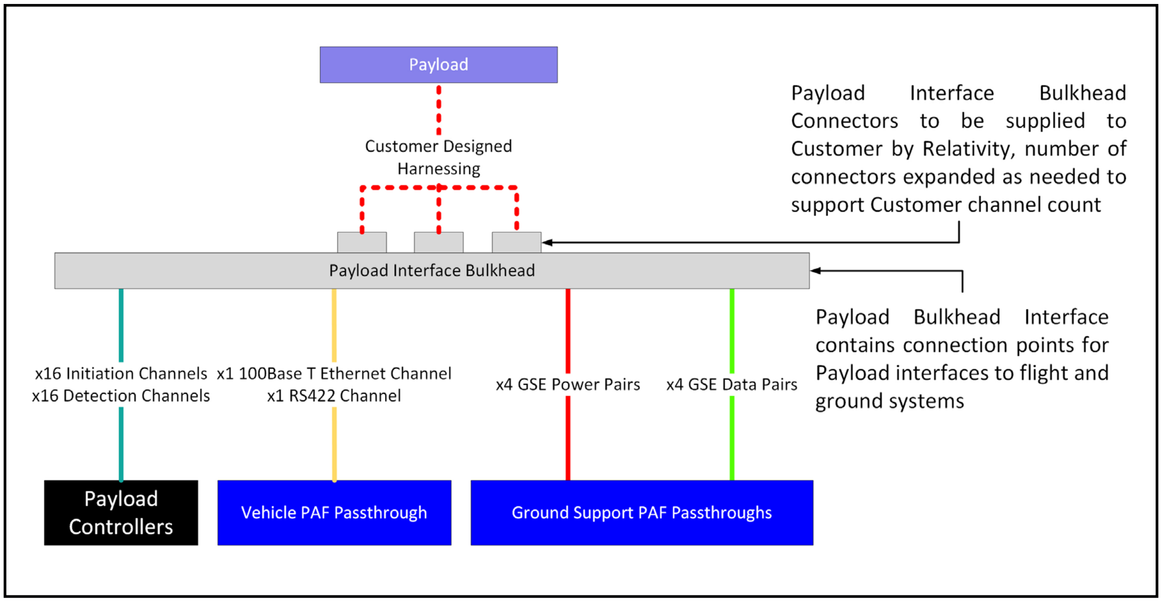
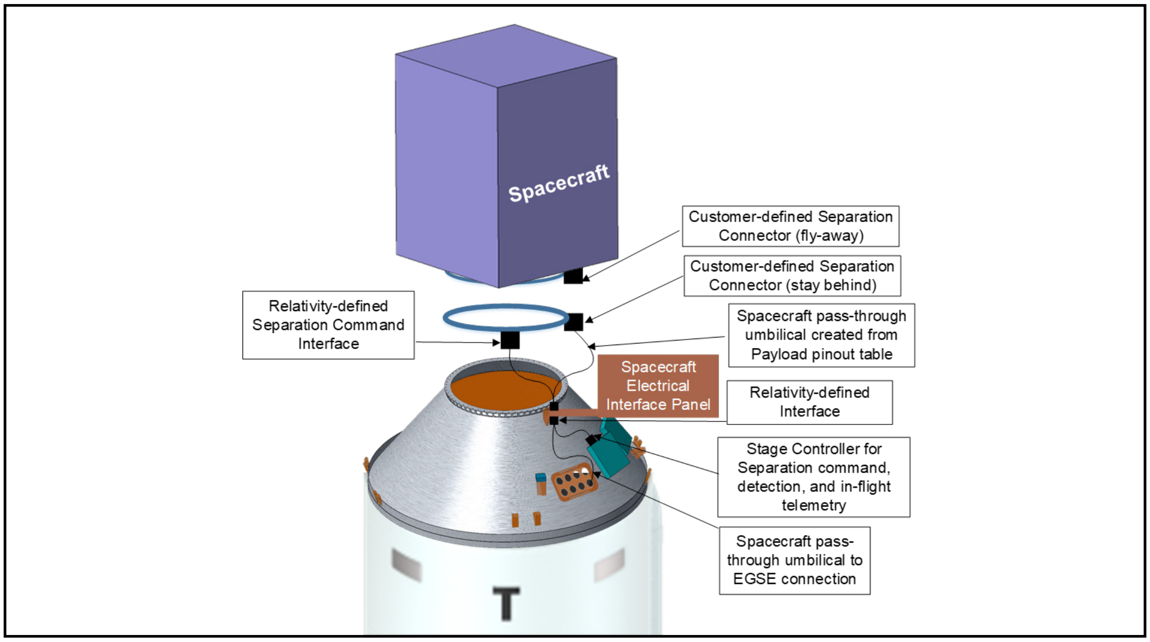


FIGURE 15 | **Launch Configuration Electrical Interface**



PRE-FLIGHT PAYLOAD AND GROUND SUPPORT EQUIPMENT ELECTRICAL INTERFACES

Terran 1 launch services include a payload umbilical to allow connection to integrated payloads from electrical ground support equipment once integrated to Terran 1. The umbilical design includes provisions for payload power and data channels during pre-flight operations; during flight, payloads are either powered off or provide their own power and have optional usage of Ethernet or serial channels for data communication through Stage 2's telemetry in-flight. FIGURE 16 provides an overview of the pre-flight umbilical configurations, and

TABLE 6 describes standard channel type and count, where Relativity's standard umbilical design utilizes MIL-STD-38999 Series 3 connectors for ground support and launch vehicle interfaces.

FIGURE 16 | **Pre-flight Umbilical Connections**

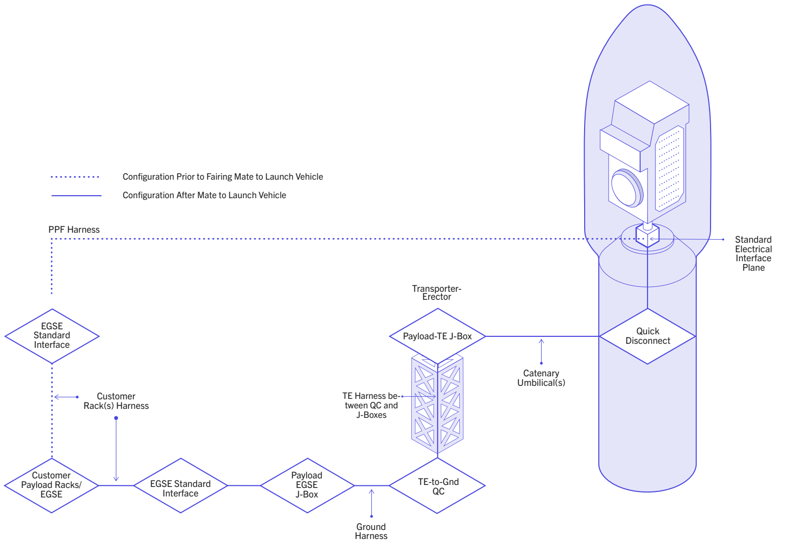


TABLE 6 | **Payload Electrical Interface Channel Availability**

SYSTEM	INTERFACE OFFERED	GAUGE (AWG)	NO. OF CONDUCTORS
Payload Ground Support Equipment	Power/General Conductor	20	8
Payload Ground Support Equipment	100 Ohm Matched Impedance	24	8
Launch Vehicle Flight Computer	100Base T Ethernet	24	4
Launch Vehicle Flight Computer	RS422 Serial	24	4
Launch Vehicle Payload Controller	Launch Vehicle-to-Spacecraft Separation Detection	20	32
Launch Vehicle Payload Controller	Separation Initiator	20	32

SEPARATION INITIATION AND DETECTION

Stage 2's avionics performs separation initiation and detects separation, with the standard service including 32 conductors allocated for each purpose. Terran 1's payload controller can be configured to expand the number of separation initiation and detection signals as part our nonstandard services. A forward facing video camera mounted on the PAF provides additional verification of fairing and payload deployment in flight.

6.0

PAYLOAD ENVIRONMENTS

PAYLOAD ENVIRONMENTS

6.1 | STEADY LOAD FACTORS

Payload steady load factors shown in FIGURE 17and TABLE 7 act on the payload net center of gravity and are valid for configurations meeting the fundamental frequency limits herein and for masses above 450 kg. Load factors for lighter payloads are determined on a case-by-case basis as part of mission-specific development and execution. These levels consider all flight and ground events, from payload encapsulation to separation including a short distance transit from payload processing facility (PPF) to the Terran 1 integration location. These load factors serve as preliminary guidance in advance of a mission-specific coupled loads analysis. Positive axial acceleration denotes compression.

FIGURE 17 | Payload Steady Load Factors (P99/90)

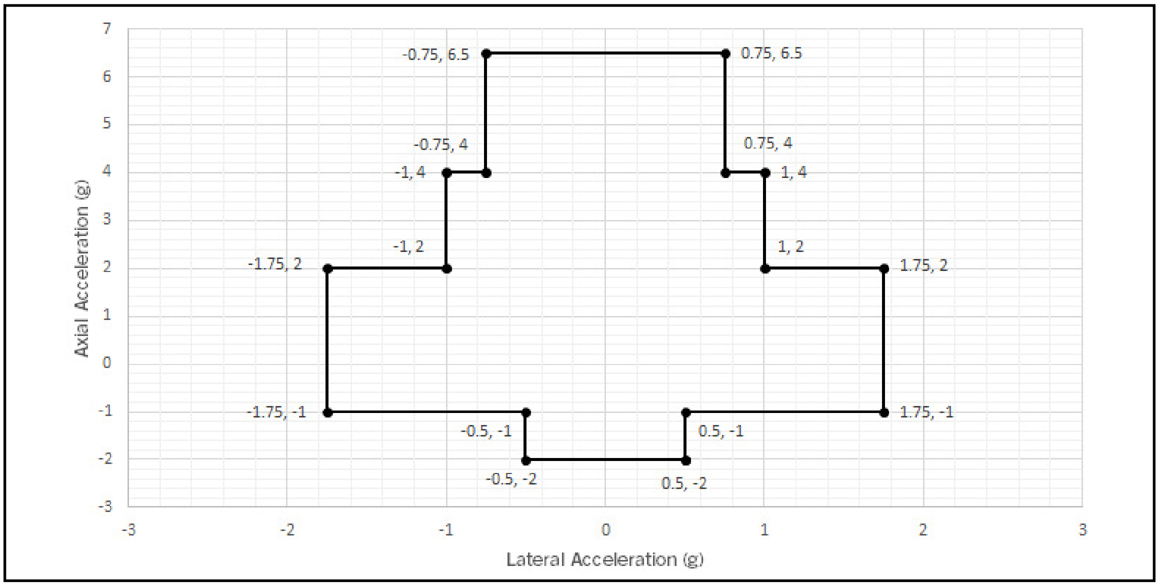


TABLE 7 | Payload Load Factors (P99/90)

AXIAL [g]	LATERAL [g]
6.5	+/- 0.75
4	+/- 1.0
2	+/- 1.75
-1	+/- 1.75
-2	+/- 0.5

6.2 | RANDOM VIBRATION

Terran 1 is designed to have random vibration environments in family with similar two-stage launch vehicles. Relativity recommends that customers design payloads to meet NASA-STD-7001 vibroacoustic test criteria.

6.3 | ACOUSTIC LOADS

During flight, the payload is subjected to a varying acoustic environment, with acoustic levels highest during liftoff and transonic flight. Predicted acoustic levels experienced by the payload depend on payload geometric and mass characteristics. The acoustic environment shown in FIGURE 18 and TABLE 8 is presented in 1/3-octave bands using 40% fill factor and conservatively envelopes launches from both launch sites.

FIGURE 18 | **Maximum Predicted Acoustic Environment (P95/50, 40% fill factor)**

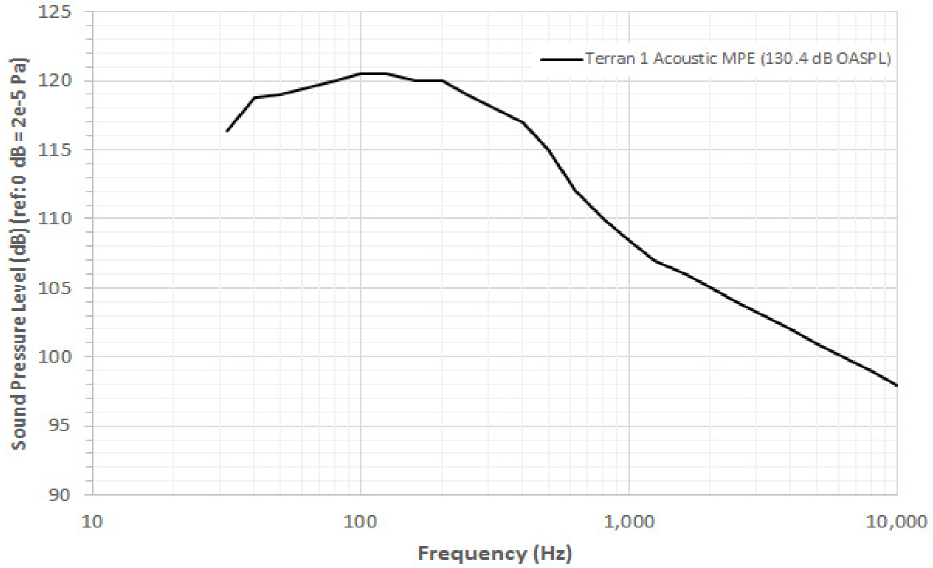


TABLE 8 | **Maximum Predicted Acoustic Environment (P95/50, 40% fill factor)**

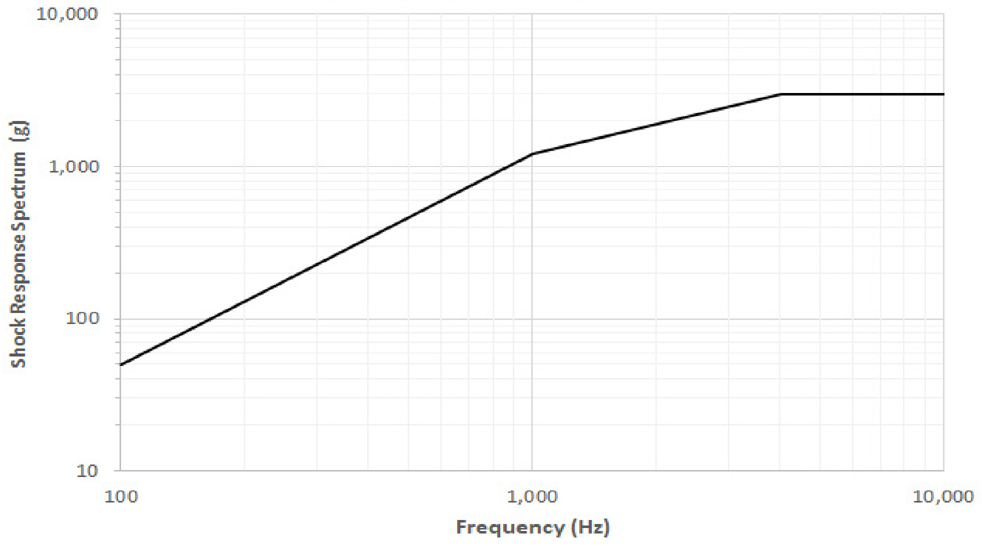
1/3RD OCTAVE BAND CENTER FREQUENCY [Hz]	SOUND PRESSURE LEVEL [dB, ref 20 µPa]
31.5	116.4
40	118.8
50	119
63	119.5
80	120
100	120.5
125	120.5
160	120
200	120

1/3RD OCTAVE BAND CENTER FREQUENCY [Hz]	SOUND PRESSURE LEVEL [dB, ref 20 µPa]
250	119
315	118
400	117
500	115
630	112
800	110
1000	108.5
1250	107
1600	106
2000	105
2500	104
3150	103
4000	102
5000	101
6300	100
8000	99
10000	98
Overall Sound Pressure Level	**130.4**

6.4 | SHOCK RESPONSE SPECTRUM

Maximum shock at the payload interface is expected during payload separation, with shock environment levels dependent on separation system configuration. Mission-specific shock environments are determined following selection of a mission-specific adapter and separation

FIGURE 19 | **Shock Response Spectrum for Terran 1 Shock Sources (P95/50)**



system. The maximum predicted shock response at the payload attach fitting interface from all launch vehicle shock sources is shown in FIGURE 19 and TABLE 9.

TABLE 9 | **Shock Response Spectrum (P95/50)**

FREQUENCY [Hz]	PEAK SHOCK ACCELERATION RESPONSE [g, Q=10]
100	50
1000	1200
4000	3000
10000	3000

6.5 | FAIRING PRESSURE AND VENTING

During pre-launch processing, fairing environmental conditioning systems maintain positive pressure to keep out contaminants while encapsulated. During ascent, the fairing internal pressure decays at a rate no higher than 3.4 kPa/sec (0.5 psi/sec) through immediately prior to fairing separation, except for a brief transonic spike, in which the decay rate will be no greater than 4.1 kPa/sec (0.6 psi/s) for no more than 5 seconds.

6.6 | PRE-LAUNCH THERMAL ENVIRONMENT

From the time the payload arrives at Relativity processing facilities until launch, Relativity provides an environmental conditioning system to maintain temperatures between 21± 5 °C (70 ± 10 °F) and humidity between 35% and 65% during ground processing. When considering time moving averages for temperature limits, Relativity designs supporting systems and processes such that no temperature peaks greater than 5.6 °C (10 °F) lasting longer than 5 minutes will occur.

6.7 | FLIGHT THERMAL ENVIRONMENT

During flight and until fairing separation, the payload is exposed to radiative heat flux. Fairing thermal insulation is sized so that no component with a view factor to the payload in the fairing exceeds 100 °C (212 °F). Fairing emissivity is approximately 0.9 for any part of the fairing assembly the payload has view factor to.

6.8 | FREE MOLECULAR HEATING

Maximum free molecular heat loads are calculated for each flight. At the time of fairing jettison, the free molecular heating (FMH) is less than 1,135 W/m^2 (0.1 BTU/ft^2-sec). This value can be adjusted to meet specific mission requirements.

6.9 | CLEANLINESS

Payloads are maintained in a Class 100,000 environment (equivalent to the Class 8 environment defined in ISO Standard 14644-1) during payload processing and launch operations.

6.10 | ELECTROMAGNETIC ENVIRONMENT

From the time the payload arrives at Relativity processing facilities through launch, the payload is exposed to radiated emissions from Terran 1, and both the launch pad and launch range infrastructure. Payloads must take the following environments into account to ensure payload materials or components sensitive to RF environments are compatible. Environments presented herein are as calculated at the PAF forward interface plane.

MAXIMUM ALLOWABLE PAYLOAD RADIATED ELECTRIC FIELD EMISSIONS

Payload radiated electric field emissions (at the PAF, and at 1 meter from the Payload) shall not exceed the levels shown in FIGURE 20 and TABLE 10.

FIGURE 20 | **Maximum Allowable Payload Radiated Emissions (at PAF)**

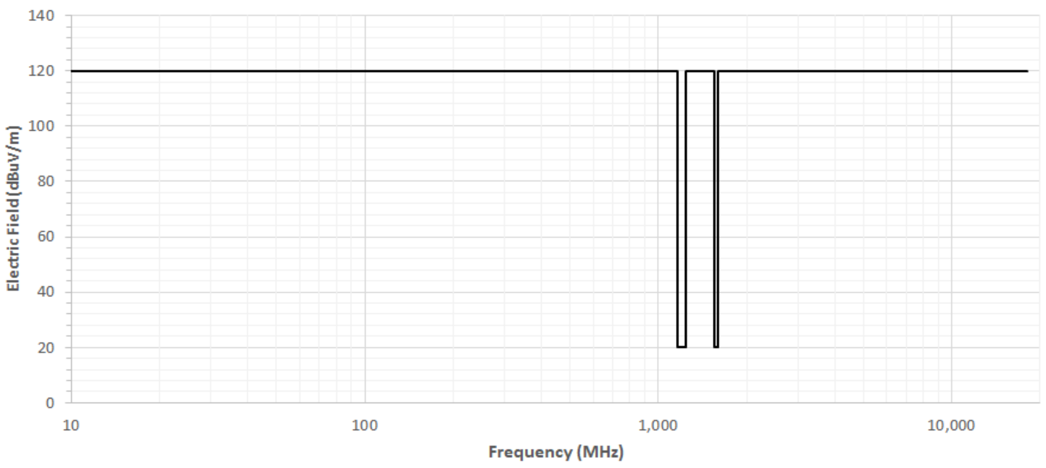


TABLE 10 | **Maximum Allowable Payload Radiated Emissions**

FREQUENCY RANGE (MHz)	E FIELD (dBµV/m)
10-1,164	120
1,164-1,237	20
1,237-1,555	120
1,555-1,595	20
1,595-18,000	120

TERRAN 1 INTENTIONAL AND UNINTENTIONAL RADIATED EMISSIONS

Terran 1 radiated electric field intentional and unintentional emissions (at the PAF) will not exceed the levels shown in FIGURE 21 and TABLE 11.

FIGURE 21 | **Terran 1 Radiated Emissions (at PAF)**

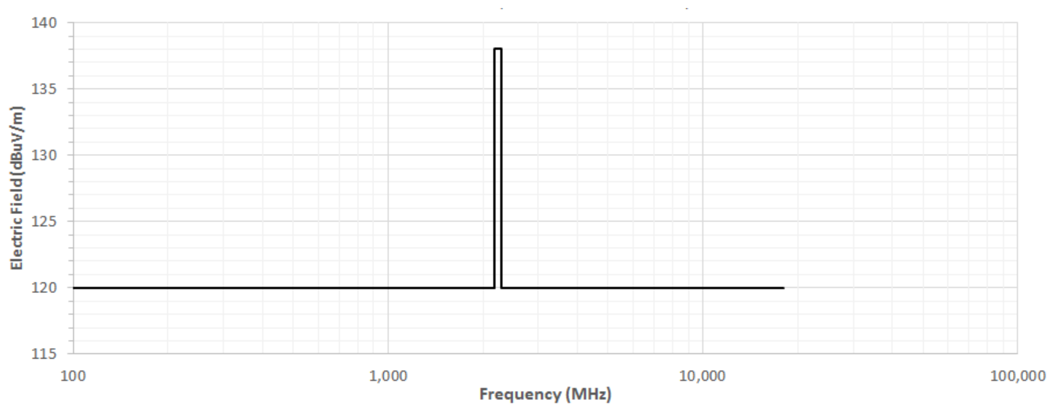


TABLE 11 | **Terran 1 Radiated Emissions**

FREQUENCY RANGE (MHz)	E FIELD (dBµV/m)
10-2,180	120
2,180-2,290	138
2,290-18,000	120

LAUNCH SITE RADIATED EMISSIONS

FIGURE 22 and TABLE 12 show the enveloped SLC-16 and B330 launch site radiated emissions environment from Terran 1, the launch pad, and the launch range based on TOR-2012(1663)-1 (CCAFS, SLC-16) and TOR-2009(3908)-9178 RevA (VAFB, ref. SLC-8), including the Terran 1 S-band transmitter.

FIGURE 22 | **Launch Site Radiated Emissions (at PAF)**

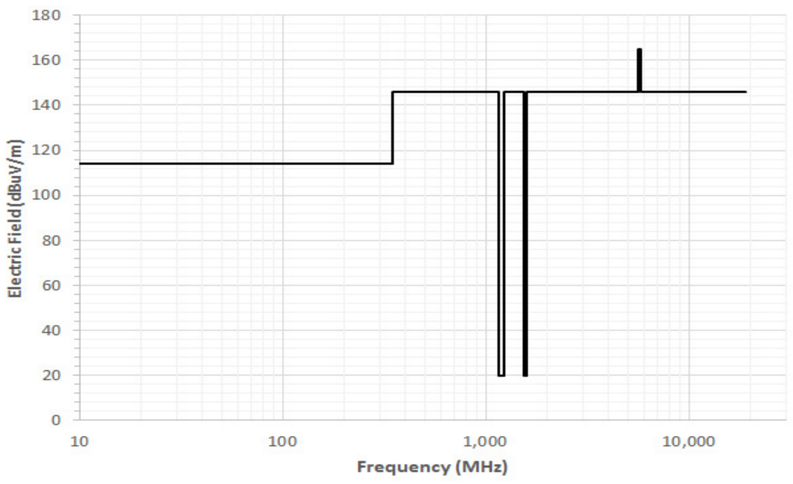


TABLE 12 | **Launch Site Radiated Emissions**

FREQUENCY RANGE (MHz)	E FIELD (dBμV/m)	E FIELD (dBμV/m)
10-350	120	1
350-1,164	146	20
1,164-1,237	20	$1x10^{-5}$
1,237-1,555	146	20
1,555-1,595	20	$1x10^{-5}$
1,595-3,040	146	20
3,040-3,060	149.5	30
3,060-5,650	146	20
5,650-5,850	165	182
5,850-9,380	146	20
9,380-9,440	149.5	30
9,440-19,000	146	20

LIGHTNING PROTECTION & ELECTROMAGNETIC INTERFERENCE

Lightning protection is provided at the Stage 2 quick disconnect, and at the spacecraft electrical interface plane to mitigate effects of lightning on the payload module. To mitigate potential negative effects of space weather, Relativity takes solar flare proton events and magnetospheric charging electron events into account as part of its launch commit criteria.

6.11 | PAYLOAD DESIGN REQUIREMENTS

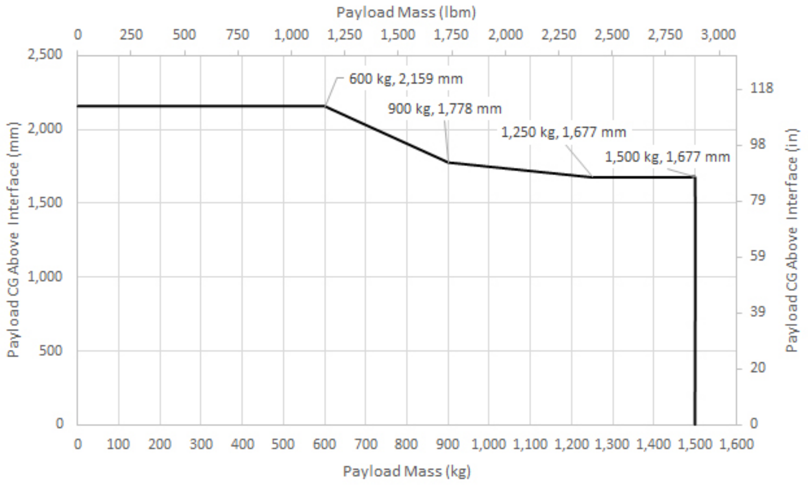
MASS PROPERTIES LIMITS

Terran 1's payload attach fitting is designed to accommodate payloads with a launch configuration center of mass which does not exceed the values shown in FIGURE 23. Payload assembly mass properties are assessed for all items forward of the payload attach fitting bolted interface, including separation systems. A payload assembly's center of mass lateral offsets should not exceed 127 mm (5 in) from the launch vehicle centerline. Mass properties must be verified by measurement before shipment to processing facilities. For small satellites who are a part of a larger payload assembly, separation mechanism compatibility (once selected) and configuration of payload assembly often govern by the mass property constraints for smaller payloads.

PAYLOAD FUNDAMENTAL FREQUENCIES

To avoid dynamic coupling with the launch vehicle, the payload assembly integrated to the PAF should exhibit a first axial fundamental frequency above 35 Hz and a first lateral fundamental frequency above 12 Hz. Payload configurations with lower fundamental modes are analyzed in a coupled loads analysis, once on contract, to assess specific dynamic loads and possible interaction with vehicle controls.

FIGURE 23 | Payload Center of Mass Not-to-exceed Envelope (Attached to PAF)



PAYLOAD GROUNDING

Payloads shall be grounded to Terran 1 spacecraft electrical interface plane (SEIP) and PAF as follows:

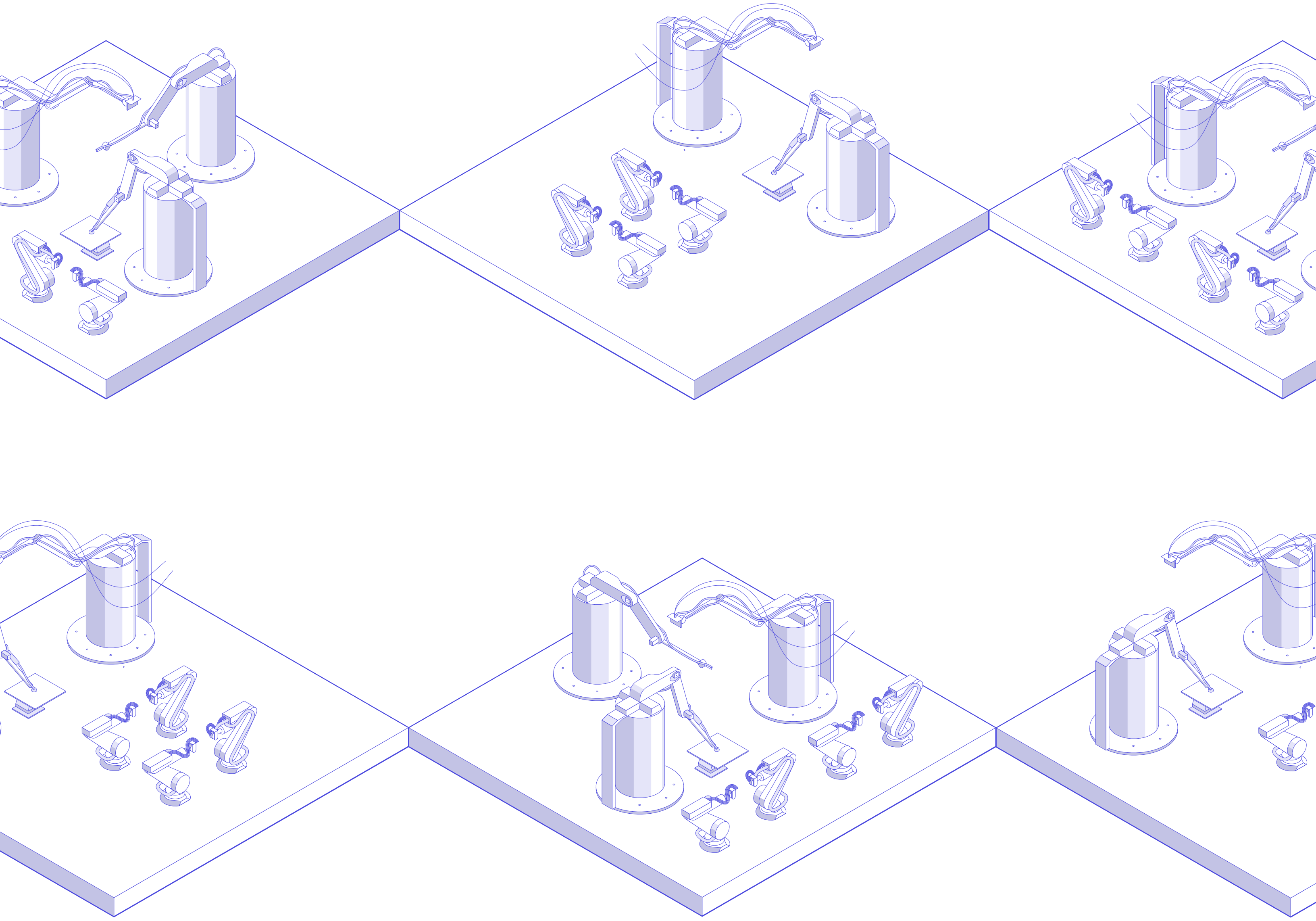
- The payload and/or payload assembly shall be employ a single point ground to the PAF and SEIP with an electrical resistance of 2.5 milliohms or less to Terran 1 structure
- The payload shall not use electrical ground as a power return to Terran 1 or EGSE
- Where ground straps are necessary to ground the payload and/or payload assembly, the ground straps shall have an electrical resistance of 2.5 milliohms or less, and inductance of 100nH or less
- Electrical wiring from PAF SEIP to the payload and/or payload assembly should be 360 degree shielded wire [consistent with SAE-AS-22759/33 (Ag/Cu)], employing connectors with 360 degree shield terminations, grounded to SEIP structure with 2.5 milliohms or less

6.12 | PAYLOAD SAFETY

Payload design should comply with safety requirements in U.S. Air Force Space Command Manual (AFSPCMAN) 91-710, tailored per customer request. Relativity also requires that payload design and operations do no harm to the launch vehicle, neighboring payloads, or integration personnel.

6.13 | PAYLOAD DEBRIS MITIGATION

Payload mission design should comply with IADC Space Debris Mitigation Guidelines as is required to support launch licensing through the U.S. Federal Aviation Administration.



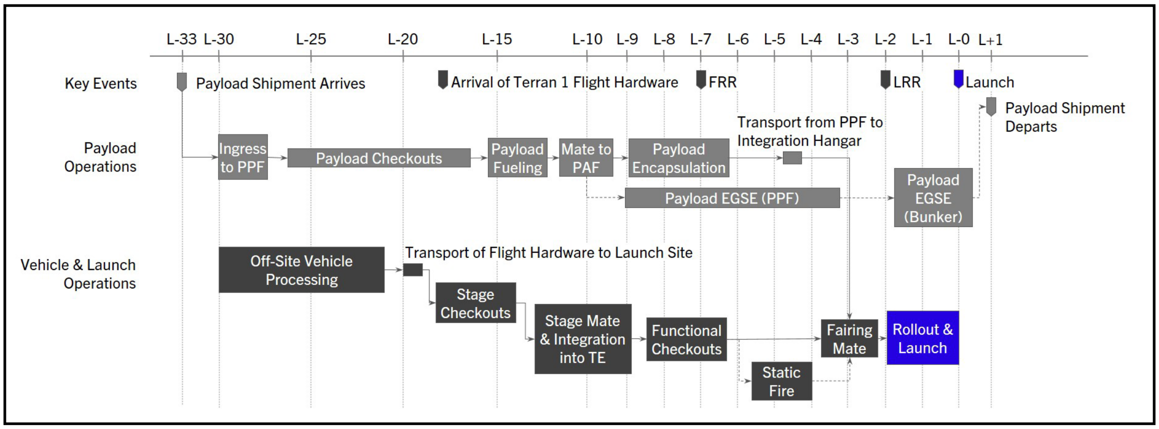
7.0

LAUNCH OPERATIONS

OVERVIEW
& SCHEDULE

Relativity's launch vehicle systems and operations are designed for a typical launch campaign duration of 30 days from customer hardware ingress into the airlock to launch. FIGURE 24 illustrates a typical launch campaign flow.

FIGURE 24 | Launch Campaign Flow



7.1 | PAYLOAD PROCESSING

Payload processing starts with delivery of the payload to the payload processing facility (PPF) and includes final processing, standalone tests, along with encapsulation within the fairing and integrated testing and checkouts (FIGURE 25). Integration of payloads to the payload attach fitting occurs in the vertical orientation, followed by payload encapsulation and break over to horizontal to mate to Stage 2. Following mate of the payload to the launch vehicle, payload processing teams utilize Relativity-provided EGSE interfaces for power and data connections to the payload.

7.2 | PAYLOAD PROCESSING FACILITY

The environmentally controlled payload processing facility provides infrastructure and equipment for processing and encapsulating payloads in the Terran 1 payload module. It consists of a Class 100K clean room, dedicated power, and consumables. Relativity also provides 24/7 gate security, badge-access secured facilities and 24/7 closed circuit video facility monitoring while a customer's personnel and/or equipment are present at payload processing and launch facilities. Floor space is available for customer ground support equipment and personnel. Customers must provide any electrical interfaces needed for customer ground support equipment to connect to facility power.

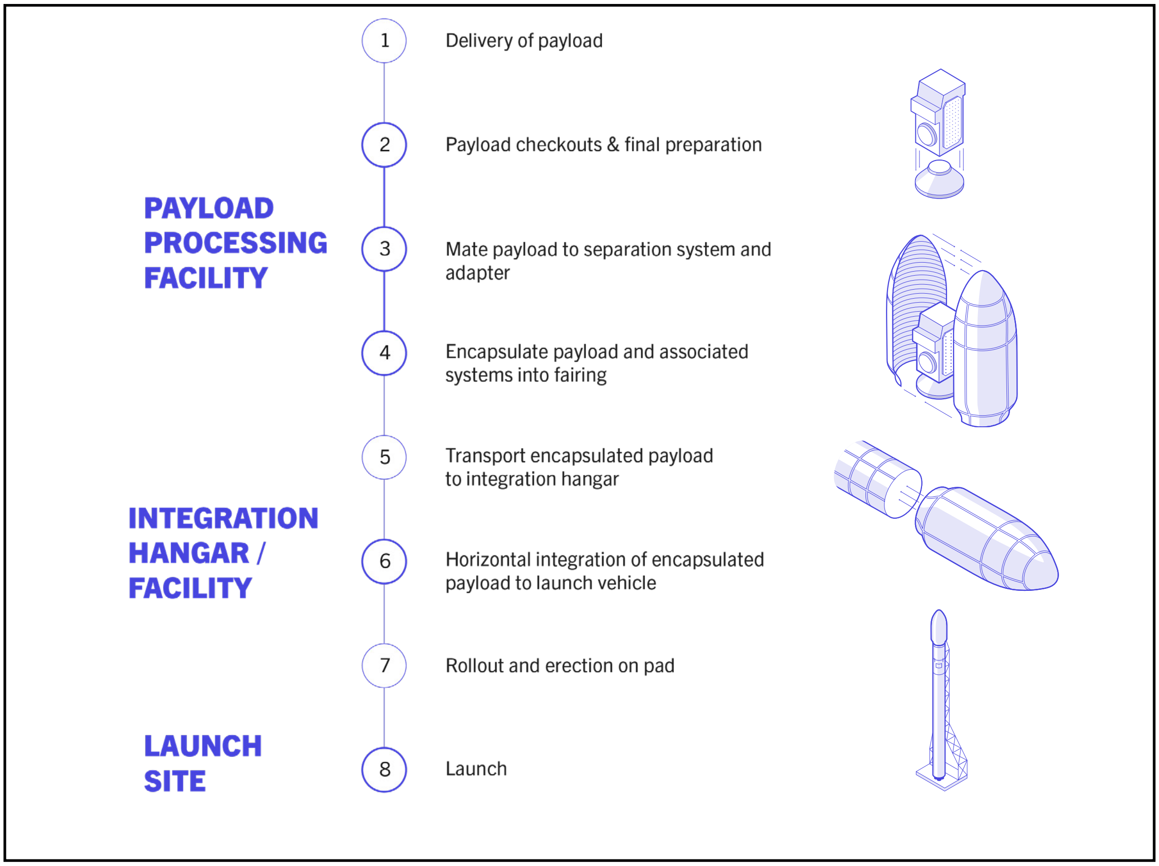


FIGURE 25 | **Payload Processing**

7.3 | LAUNCH CONTROL

Relativity's main launch control center is located at its Long Beach, California, headquarters, with smaller, localized control centers at the launch sites, consisting of consoles that use standard desktop PCs and displays with custom graphical user interfaces, along with voice communication systems, including a digital matrix intercom system (voice-nets), voice over internet protocol (VoIP), and IP phones. Additional viewing monitors are positioned throughout the control rooms, with video and control provided over IP systems.

7.4 | COUNTDOWN & LAUNCH PROCEDURES

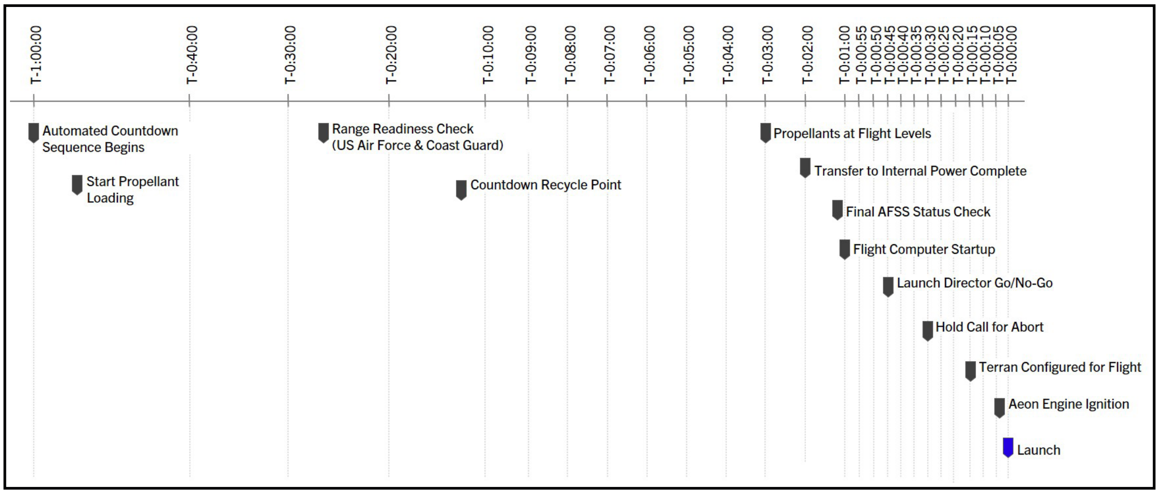
PAD OPERATIONS

Approximately one week prior to launch, Relativity conducts a flight readiness review (FRR) to verify readiness of the launch vehicle, integrated payload, and ground systems. Once verified, the integrated Terran launch vehicle rolls to the pad and connects to ground systems including payload/fairing conditioning, pressurants, propellants, and electrical and data connectivity. When ground support connections are complete, the transporter erector rotates the Terran launch vehicle to its vertical position on the pad.

COUNTDOWN

The Terran launch vehicle and pad systems are designed to accommodate a one-hour countdown; longer countdowns may be coordinated as a nonstandard service. Critical functions for both ground systems and flight vehicle are controlled by automated software during the countdown. Propellant and pressurant loading sequences begin early in the countdown, along with a series of vehicle, telemetry, and range checkouts, with verification of AFSS, transmitter activation, and transitions from ground to internal power taking place during the final minutes of terminal count. FIGURE 26 shows a launch countdown overview; this does not include all countdown functions and is for reference only.

FIGURE 26 | **Launch Countdown Timeline**



RECYCLE AND SCRUB

The Terran launch vehicle systems and operations allow for recycle operations when viable, where baseline operations allow for a single recycle, allowing for two launch attempts within a four-hour launch window. In the event of a scrub, Relativity will secure the launch vehicle on the pad, while maintaining environmental control and power to the payload through the ground support umbilical. For long postponements, or if there is a need to access the payload, Relativity will bring the Terran launch vehicle to the horizontal position and roll back to the integration hangar once de-fueled.

8.0

MISSION ASSURANCE

MISSION
ASSURANCE

Mission assurance at Relativity spans the full lifecycle of its launch services, from launch vehicle design through post-flight data analysis. Our integrated approach to mission assurance includes adherence to an internally tailored version of SMC-S-016 / MIL-STD-1540E for component, system, and vehicle-level qualification & acceptance testing. Relativity's quality management process follows established aerospace quality norms such as ISO, AS9100, ASTM, and AWS. Launch vehicle drawings and designs as well as 3D printers are configuration-controlled using configuration management practices. Our production flow is seamlessly managed from raw materials through launch vehicle production using our Enterprise Resource Planning system which is specifically tailored to Relativity's production and launch model. Relativity participates in ASTM's F42 Committee on Additive Manufacturing's sub-committee "Spaceflight," which an example of our contribution to additive manufacturing standards that help to standardize our process and provide benefit for the industry at large.

Launch vehicle, payload, and integration campaign requirements are captured in a collaborative requirements management system, where each requirement is reviewed, approved, and verified by customers and Relativity engineering as part of mission planning.

8.1 | MISSION MANAGER

The Relativity mission manager is a key component of our mission assurance approach. He/she acts as a single point of contact to the customer for all program management and technical direction, ensuring that customer requirements are clearly captured and verified by the Relativity team while coordinating all technical activities related to the payload integration and launch campaign. The mission manager works with each customer to develop and verify payload-to-launch vehicle interface control requirements (collectively known as the ICD). Mission schedules, requirements, verification matrix and status, program deliverables, and technical interchanges are accessible through Relativity's state of the art 'Command Center' which serves as an efficient, single source of truth for customer program management.

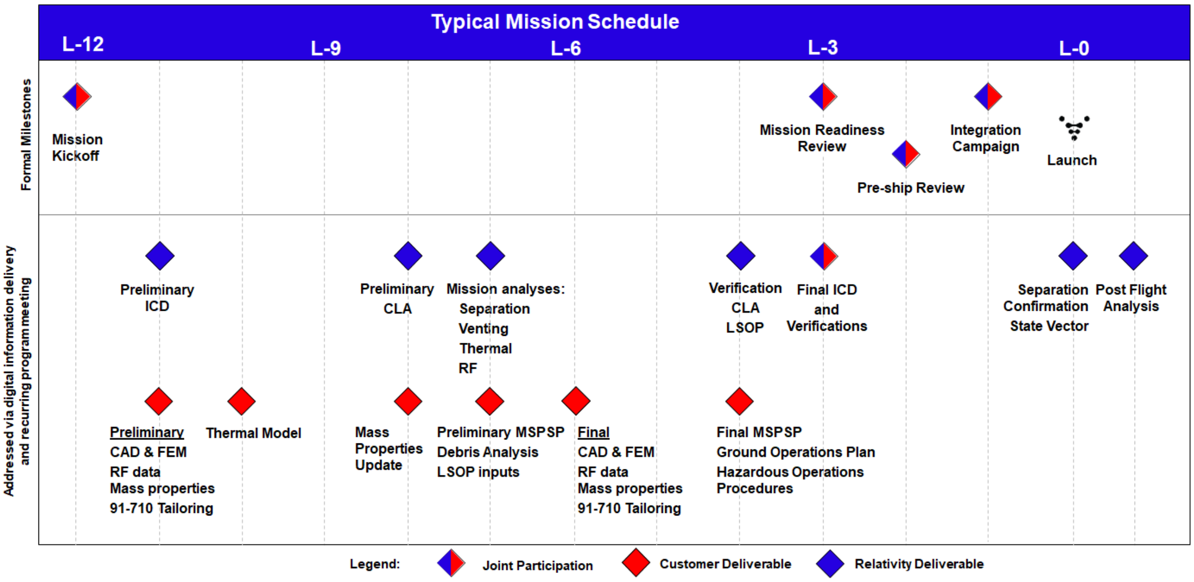
Relativity coordinates program status meetings, typically held once per month from mission kickoff until L-12 months, then held every two weeks and conducted via web conference. The program status meetings include mutual updates on the following topics throughout the performance of a mission:

- review of program progress as a function of work planned
- status of ICD definition and verification
- status of key technical issues and risks and plans for resolution
- status of Mission integration analyses
- status of Customer compliance with regulatory requirements for Launch including Wing Safety and applicable Payload licensing deliverables

8.2 | STANDARD MISSION INTEGRATION SCHEDULE

The typical mission integration timeline and deliverables (FIGURE 27) are based on a standard 12-month schedule. Schedules and missions can be accelerated to accommodate individual customer requirements; please contact Relativity for further details.

FIGURE 27 | **Typical Mission Schedule and Deliverables**



Launch service begins once the Launch Services Agreement (LSA) is signed, authorizing requirements definition, mission analyses, and launch campaign coordination. The launch campaign kicks off at L-1 month with the arrival of the payload at the payload processing facility. Flight readiness review commences 5 days prior to the launch date, verifying that all systems and support functions are ready for launch. Confirmation of separation and preliminary state vectors are provided within 60 minutes of deployment. Within one month following a launch, Relativity provides a post-launch analysis which assesses Terran 1 performance in comparison with the requirements in the ICD.

Terran 1's rapid production timeline means that vehicle readiness does not often drive the mission timeline; typically, it is launch scheduling, requirements definition and verification, receipt of necessary licenses, and spacecraft readiness which pace the launch readiness timeline. Given this significant reduction of vehicle readiness constraint, Relativity's mission execution process is optimized to reduce complexity in requirements and verification, and to enhance visibility into upcoming tasks and task status, and transparency into all required deliverables from time of LSA execution which results in reduced effort required for customer program management of Relativity's launch service. As such, Relativity is changing the paradigm by designing production and mission execution processes to be responsive to customer demands.

8.3 | REQUIREMENTS, VERIFICATIONS, AND DELIVERABLES

A detailed statement of work and mission technical specification, including standard and nonstandard services, is developed during contract negotiation upon which all contractual obligations are derived. The following four categories of deliverables summarize the majority of the efforts required for to plan and execute a successful mission:

- Interface requirements and verifications (e.g. orbit, interface, integration campaign support, safety)
- Mission unique design analyses utilizing payload input models and information (CLA, CAD, thermal, radio frequency characteristics, etc.)
- Spacecraft integration and launch operations plans, including customer shipment and personnel logistics, ground and hazardous operations procedures
- Licensing and certifications including, but not limited to, ITAR/EAR licenses, Federal Communications Commission (FCC) licenses, US Department of Transportation dangerous goods permits, ITU/NTIA frequency coordination, and certifications of compliance

8.4 | READINESS REVIEWS

In performing Relativity's responsibilities, Relativity coordinates recurring mission planning meetings and milestone-related program reviews involving Relativity and customer program teams as described below.

- Kickoff Meeting, Pre-ship Review, Launch Readiness Review, and Flight Readiness Review (in each case, to correspond with the Mission Schedule)
- Working group meetings to discuss topics that cannot be handled unilaterally such as integration planning, launch site operations, and launch campaign planning
- Technical Interchange Meetings focused on resolving specifically identified technical issues

Action items from program reviews are tracked until action items are resolved or a mutually agreed plan for closure is developed.

8.5 | RISK REDUCTION BY DESIGN

Relativity uses the same family of industrial automation controller models to run our component test stands, test sites, and launch sites, which enables a test-like-you-fly approach while dramatically simplifying drivers and firmware configuration management. As a standard part of our production process, Relativity performs fully integrated hardware-in-the-loop and vehicle-in-the-loop mission simulations for full system validation. Hardware acceptance processes include traceability of raw material, inventory control in the factory, lot quality verification, configuration management for parts, systems, and printers, non-destructive inspection (in process and post-manufacture), as well as acceptance and proof testing of all primary and low-margin secondary structures. Aeon engines are tracked at the component level using material certification, dimensional inspections, proof pressure and flow tests. At the Aeon sub-assembly level, torque is verified, secondary retention features are installed, and leak checks are performed. At the Aeon engine assembly level, the same torque/retention/leak activities are performed in addition to acceptance test firing of each engine assembly which also verifies engine controller functionality (FIGURE 28). Stage-level workmanship is verified by mission duration hot fires performed on both Stage 1 and Stage 2 before final integration of the flight vehicle. Once assembled, a static fire hold down test is performed before final integration of the payload module to Terran 1. As a last and final verification, Terran 1 must achieve full thrust before the launch mount hold downs release the vehicle.

FIGURE 28 | **Thrust and Stage Level Verification Tests**

Individual Engine Acceptance Testing:
Aeon-1 and AeonVac

Stage Acceptance Testing:
Stage 1 and Stage 2

Terran 1 Hold Down Test
(without payload module)

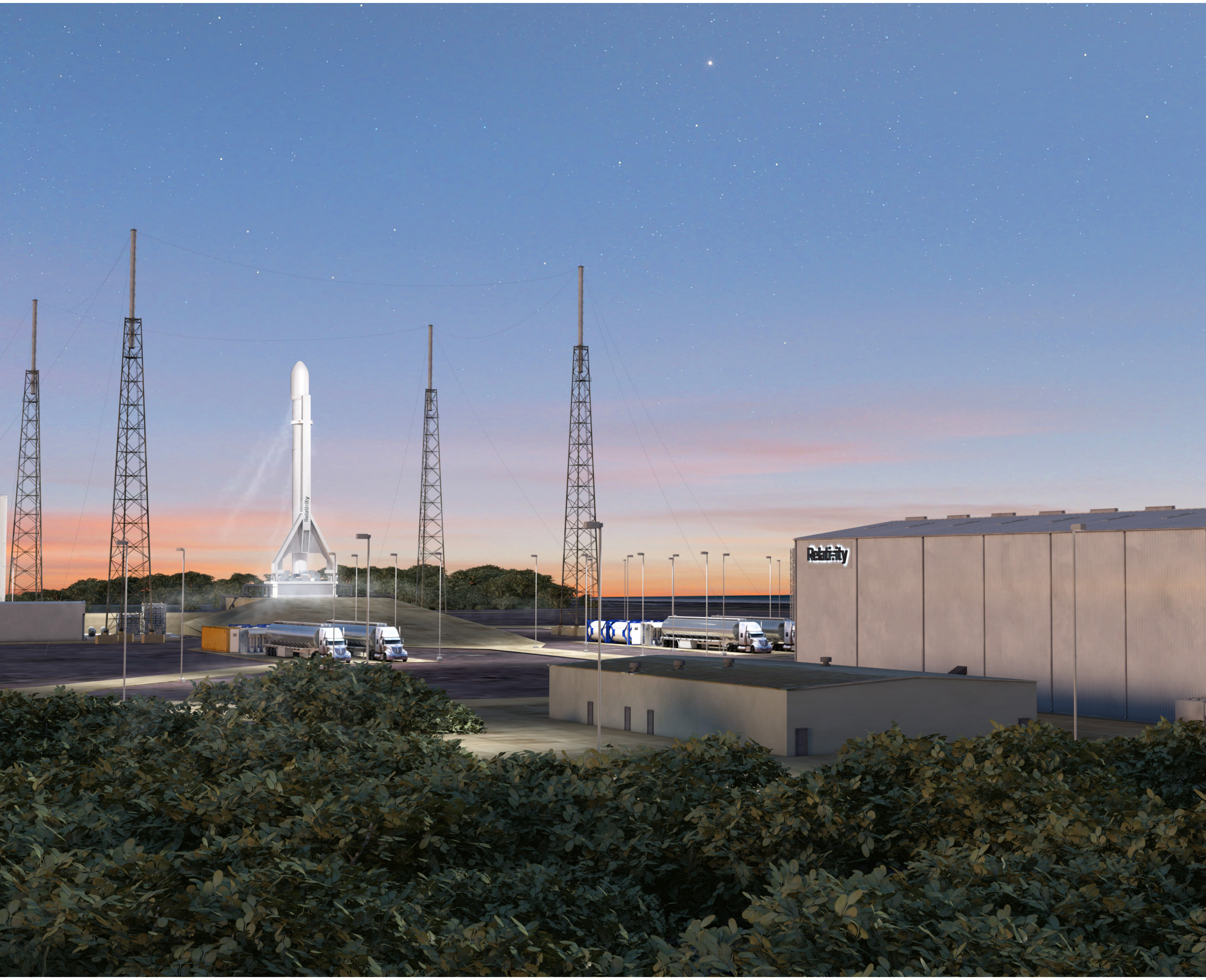
Launch:
100% thrust verified
before release

For purchased separation system and adapter hardware that interfaces with the payload directly, Relativity employs acceptance inspections, serial number based inventory management, and secure caged storage in its factory to preserve quality.

Relativity uses an Issue system to track, document, and resolve issues involving test and flight hardware and software, specifically during development, production, test, and operations. Issues tracked include known or suspected cases of:

- Hardware defects/deviations from approved design
- Anomalous hardware/system behavior
- Adverse events that may have resulted in hardware damage
- Process deviations
- Required modification of design or process (discovered mid-build, or process execution).

Relativity uses a Risk Ticket system to track and drive Terran and Mission Program risks to closure. Risk tickets require mitigation plans, status, and buy-off from Relativity leadership as entry criteria for Flight Readiness Review.



9.0

DOCUMENT REFERENCE

9.1 | LIST OF FIGURES

9.2 | LIST OF TABLES

9.3 | LIST OF ABBREVIATIONS, ACRONYMS, AND UNITS

3D	Three Dimensional
AFSPCMAN	Air Force Space Command Manual
AFSS	Autonomous Flight Safety System
AFTU	Autonomous Flight Termination Unit
Ag	Gold
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWS	American Welding Society
BTU	British Thermal Unit
°C	Degrees Celsius
CAD	Computer-Aided Design
CCAFS	Cape Canaveral Air Force Station
CLA	Coupled Load Analysis
Cu	Copper
dB	Decibels
DMLS	Direct to Metal Laser Sintering
EAR	Export Administration Regulations
E Field	Electromagnetic Field
EGSE	Electrical Ground Support Equipment
ESPA	EELV secondary payload adapter
°F	Degrees Fahrenheit
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FMH	Free Molecular Heating
FRR	Flight Readiness Review
Ft	Feet
GPS	Global Positioning System
Hz	Hertz
HITL	Hardware-in-the-loop
IADC	Inter-Agency Space Debris Coordination Committee
ICD	Interface Control Requirements
IMU	Inertial Measurement Units
In	Inch
IP	Internet Protocol
ISO	International Organization for Standardization
ITAR	International Trade in Arms Regulations
ITU	International Telecommunications Union
J-box	Junction Box
Kg	Kilogram
kPa	Kilopascal
L-	Launch minus

Lbf	Pound-force
LC-16	Launch Complex 16
LNG	Liquid Natural Gas
LOX	Liquid Oxygen
LRR	Launch Readiness Review
LSA	Launch Service Agreement
M or mm	Meters or millimeters
MSPSP	Missile System Pre-launch Safety Package
NASA	National Aeronautics and Space Administration
NEA	NEA Electronics, Inc
nH	Nano Henry
NSI	NASA Standard Initiator
NTIA	National Telecommunications and Information Administration
PAF	Payload Attach Fitting
PAS	Payload Adapter System
PC	Personal Computer
PPF	Payload Processing Facility
PSC	Planetary Systems Corporation, Inc.
Psi	Pounds per square inch
QC	Quick connect
RAAN	Right Ascension of Ascending Node
RF	Radio Frequency
S or sec	Seconds
SECO	Second Engine Cutoff
SEIP	Spacecraft Electrical Interface Plane
SES	Second Engine Start
SSO	Sun-Synchronous Orbit
TE	Transporter Erector
US	United States
Vac	Vacuum
VAFB	Vandenberg Air Force Base
VoIP	Voice-over Internet Protocol
W	Watts

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