RIDESHARE PAYLOAD USER'S GUIDE

November 2020

TABLE OF CONTENTS

ACRONYMS

AFSPCMAN	Air Force Space Command Manual
ATM	acceleration transformation matrix
BPSK	binary phase shift keying
CAD	computer-aided design
CCAFS	Cape Canaveral Air Force Station
CG	center of gravity
CLA	coupled loads analysis
CSLA	Commercial Space Launch Act
CSpOC	Combined Space Operations Center
DSSS	direct-sequence spread spectrum
DRM	data recovery matrix
DTM	displacement transformation matrix
EAR	export administration regulations
ECEF	earth-centered, earth-fixed
EGSE	electrical ground support equipment
EIRP	equivalent isotropically radiated power
EMI	electromagnetic interference
EMISM	EMI safety margin
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FEM	finite element model
FM	frequency modulation
FMCW	frequency modulation continuous wave
FOD	foreign object debris
GOP	ground operations plan
GPS	global positioning system
GSE	ground support equipment
HVAC	heating, ventilation and air conditioning
ICD	interface control document
IGES	initial graphics exchange specification
IRIG	inter-range instrumentation group
ITAR	international traffic in arms regulations
KSC	Kennedy Space Center
LOX	liquid oxygen
LTM	load transformation matrix
LV	Launch Vehicle
LVLH	local vertical/local horizontal
MPE	maximum predicted environment
MPT	maximum and minimum predicted temperatures
MEOP	maximum expected operating pressure
MSPSP	missile system prelaunch safety package

NASA .... National Aeronautics and Space Administration
NASTRAN .... NASA Structural Analysis
OPM .... orbital parameter message
OTM .... output transformation matrix
PAF .... payload attach fitting
PCM .... pulse code modulation
PI .... program Introduction
PL .... Payload
PPF .... payload processing facility
PSD .... power spectral density
PSK .... phase shift keying
Q .... dynamic pressure
QPSK .... quadrature phase shift keying
RE .... radiated emissions
RF .... radio frequency
RP-1 .... rocket propellant-1 (rocket-grade kerosene)
RS .... radiated susceptibility
RTV .... room temperature vulcanizing
R_X .... Payload receiver(s)
SC .... spacecraft
SCAPE .... self-contained atmospheric protective ensemble
SLC .... space launch complex
SpaceX .... Space Exploration Technologies Corp.
SPL .... sound pressure level
SSPP .... system safety program plan
STEP .... standard for the exchange of product model data
OASPL .... overall sound pressure level
SRS .... shock response spectrum
TAA .... technical assistance agreement
TE .... transporter-erector
T_X .... Payload transmitter(s)
US .... United States
UTC .... coordinated universal time
VAFB .... Vandenberg Air Force Base
VC-HS .... visibly clean – highly sensitive

LIST OF FIGURES

LIST OF TABLES

CHANGE LOG

Date	Update
03 December 2019	Original Release
29 January 2020	Updated Definitions
16 June 2020	General Updates Added distinctions between dispenser ring and Starlink rideshares General cleanup and clarification Section 2 Mass versus C.G. definition updated Clarifications on deployment direction Updated CubeSat and multi-deploy velocities Updated Launch Vehicle pre-separation rates Section 3 Updated cleanroom environments Updated combined loads including clarification on random vibration interaction Updated transition mass to 225kg Updated random vibration requirement Updated EMI section – clean up and clarification on TX timelines Updated payload unit test and durations including updated notes Section 4 Clarification on Mechanical Interface Rings and allowable Payload volume New Payload volume images Additional details added to Electrical Interface Added Launch configuration battery status requirements Appendix A Updated Mechanical Interface Ring and volume drawings Appendix D Included Encapsulation Readiness Letter Template Updated Launch Readiness Letter Template Appendix G Clean up for consistency with SpaceX Rideshare Terms & Conditions Appendix J Additional definitions
22 November 2020	Updated acronym list Section 2 Revised approach on separation requirements Section 3 Updated Loads, Sine-Vibe, EMI, and thermal MPE sections Added modifications for containerized CubeSats and metallic structures to Section 3.4 Added sine-vibe testing approach to Section 3.4 Section 4 Updated Section 4.1.5 volume allowable inside the side-mounted dispenser port interface Added umbilical specifications in Section 4.2 and minor updates Section 6 Updated separation analysis definition Appendix A Figures A-5 and A-6 updated volume allowable inside the side-mounted dispenser port interface Appendix B Refined dynamics model definition Appendix G Updated deliverables Appendix H Export classification no longer required Appendix J Additional definitions

1 INTRODUCTION

1.1 RIDESHARE PAYLOAD USER'S GUIDE PURPOSE

The Rideshare Payload User's Guide is a planning document provided for small satellite customers of SpaceX (Space Exploration Technologies Corp.). This document is applicable for a small satellite 15" or 24" diameter mechanical interface within the Falcon 9 Launch Vehicle configuration with a 5.2 m (17-ft.) diameter fairing and the related launch service. Additional mechanical interface diameters can be accommodated using a Payload adapter plate (see Appendix I). Larger payloads that do not fit within the limitations defined in Section 4 may be accommodated on top of the Rideshare hardware as shown in Figure 1-1, please contact SpaceX for more information. SpaceX also offers Rideshare capability on Starlink missions, as shown later in this document.

This Rideshare Payload User's Guide is intended to help Rideshare Launch Customers understand SpaceX's standard services for pre-contract mission planning and to delineate Customer requirements for contracted Rideshare Launch Services.

SpaceX reserves the right to update this guide as required. Future revisions are likely as SpaceX continues to gather additional data and works to improve the Rideshare program.

Figure 1-1: Example Mission Configuration using Rideshare Dispenser Rings

1.2 COMPANY DESCRIPTION

SpaceX offers a family of Launch Vehicles that improves launch reliability and increases access to space. The company was founded on the philosophy that simplicity, reliability and cost effectiveness are closely connected. We approach all elements of Launch Services with a focus on simplicity to both increase reliability and lower cost. The SpaceX corporate structure is flat and business processes are lean, resulting in fast decision-making and product delivery. SpaceX products are designed to require low-infrastructure facilities with little overhead, while vehicle design teams are co-located with production and quality assurance staff to tighten the critical feedback loop. The result is highly reliable and producible Launch Vehicles with quality embedded throughout the process.

Established in 2002 by Elon Musk, the founder of Tesla Motors, PayPal and the Zip2 Corporation, SpaceX has developed and flown the Falcon 1 light-lift Launch Vehicle, the Falcon 9 medium-lift Launch Vehicle, the Falcon Heavy heavy-lift Launch Vehicle, the most powerful operational rocket in the world by a factor of two, and Dragon, which is the first commercially produced spacecraft to visit the International Space Station.

SpaceX has built a launch manifest that includes a broad array of commercial, government and international customers. In 2008, NASA selected the SpaceX Falcon 9 Launch Vehicle and Dragon spacecraft for the International Space Station Cargo Resupply Services contract. NASA has also awarded SpaceX contracts to transport astronauts to space as well as to launch scientific satellites. In addition, SpaceX services the National Security community and is on contract with the Air Force for multiple missions on the Falcon family of Launch Vehicles.

SpaceX has state-of-the-art production, testing, launch and operations facilities. SpaceX design and manufacturing facilities are conveniently located near the Los Angeles International Airport. This location allows the company to leverage Southern California's rich aerospace talent pool. The company also operates cutting-edge propulsion and structural test facilities in Central Texas, along with Launch Sites in Florida and California, and the world's first commercial orbital Launch Site in development in South Texas.

1.3 FALCON 9 PROGRAM

Please refer to the SpaceX Falcon User's Guide, latest revision, available on www.spacex.com/vehicles/falcon-9/ for detailed information regarding the Falcon program including Launch Vehicle safety and reliability.

1.4 PRICING

Pricing for rideshare Launch Services can be found at www.spacex.com/rideshare.

2 PERFORMANCE

2.1 MASS PROPERTIES

Payloads must comply with the mass and X_{PL} center of gravity limitations given in Figure 2-1. Y_{PL} and Z_{PL} center of gravity dimensions must fall within the mechanical interface diameter for the Payload. The Payload coordinate frame is defined in Section 4.1.3. Payloads in excess of the figure can be evaluated on a case-by-case basis. Mass properties must be assessed for all items attached to the mechanical interface (Section 4.1.4), including any mission-unique Payload adapters and separation systems. Mass property capabilities may be further constrained by mission-unique Payload adapters, dispensers or separation systems. The center of gravity is relative to the Payload origin as defined in Section 4.1.3.

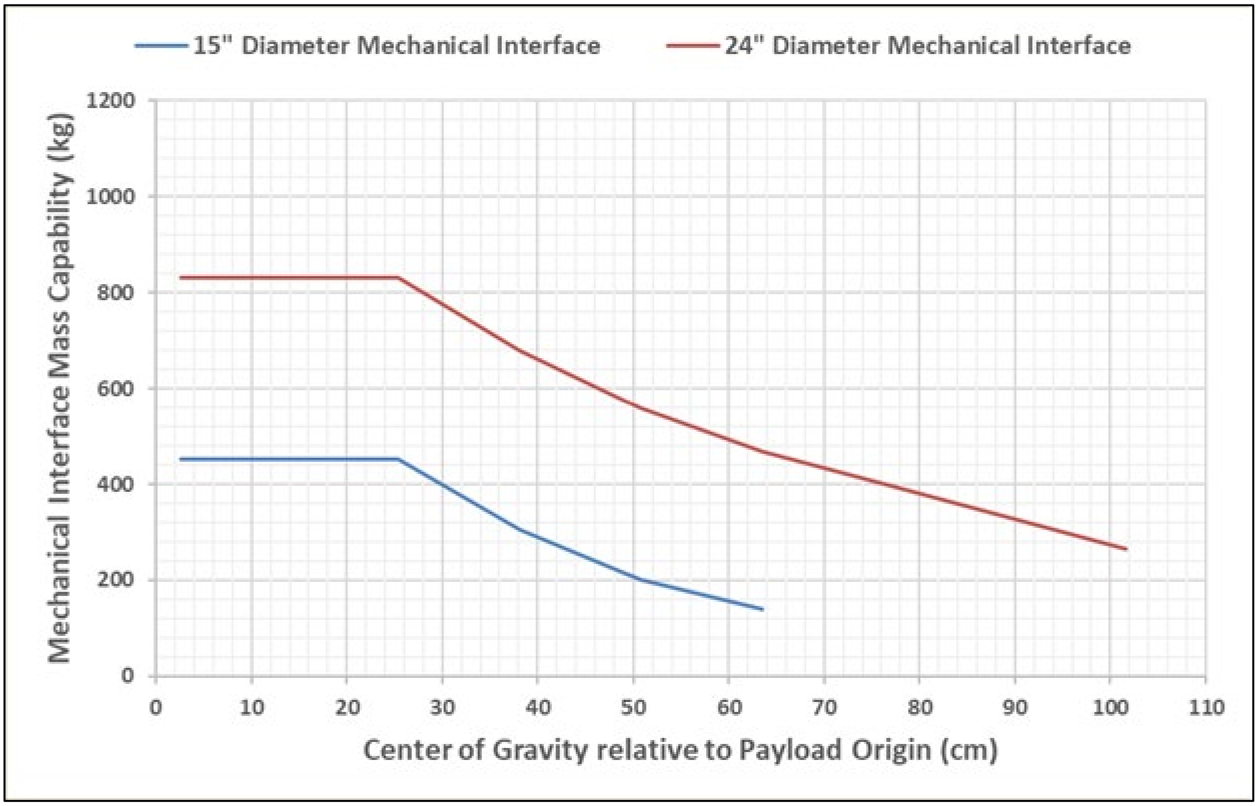

Figure 2-1: Allowable Payload Mass and X_{PL} Center of Gravity

SpaceX requires that Customer verify the mass properties of their Payload through measurement before shipping it to the Launch Site. SpaceX may request insight into relevant analyses and testing performed for Payload qualification, acceptance and interface verification. The Launch Vehicle may be able to accommodate payloads with characteristics outside the limitations indicated in this section. Please contact SpaceX with your mission-unique requirements.

2.2 LAUNCH WINDOWS

The Launch Vehicle is capable of launching any day of the year, at any time of day, subject to environmental limitations and constraints as well as range availability and readiness within the SpaceX-determined Launch Period. Launch Window times and durations are developed specifically for each Mission. Customers may benefit from recycle operations (reference Section 7.5.5), maximizing launch opportunities within the Launch Window.

2.3 SEPARATION ATTITUDE AND ACCURACY

The Launch Vehicle offers 3-axis attitude control as standard practice. The Launch Vehicle will point the second stage and Payload to an LVLH attitude as determined by SpaceX. More information about separation attitude and rate accuracy is available from SpaceX upon request.

2.4 SEPARATION RATES AND VELOCITY

Customers must ensure that the design, or placement and orientation, of a Payload Constituent's separation system allows for the deployed Payload Constituent to separate from the Launch Vehicle such that the entire body exits through the $+X_{PL}$ surface of the allowable Payload volume as described in Section 4.1.5. The +XPL surface of the allowable Payload volume corresponds to the curved surface for the dispenser ring configuration as shown in Figure 2-2 and the top surface for the Starlink adapter configuration as shown in Figure 2-3.

For Payloads with more than one deployable Payload Constituent, all deployed bodies must meet the $+X_{PL}$ surface exit requirement. Customer must show by analysis that none of the deploying bodies make contact with other Payload Constituents within the same Payload while exiting through the $+X_{PL}$ surface. Payloads or Payload Constituents that do not meet the exit plane requirement will need approval and will be evaluated by SpaceX on a case-by-case basis.

SpaceX does not have an explicit Payload separation velocity requirement. SpaceX recommends targeting a minimum separation velocity of 0.3 m/s and a maximum separation velocity of 1.0 m/s. Containerized deployments, such as CubeSats may be deployed at a velocity greater than 1.0 m/s. For Payloads that contain more than one deployment, the separation velocities should be different between deployed Payload Constituents such that the fastest deployment is first.

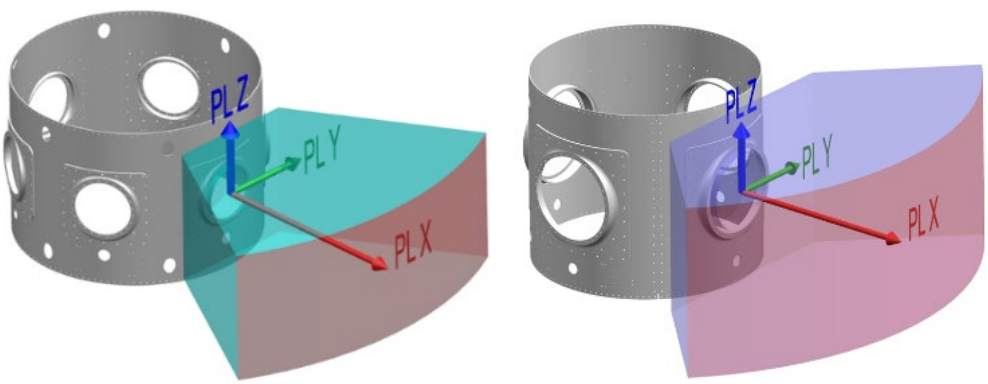

Figure 2-2: Payload $+X_{PL}$ Surface Exit Requirement (red) for Dispenser Ring Configuration

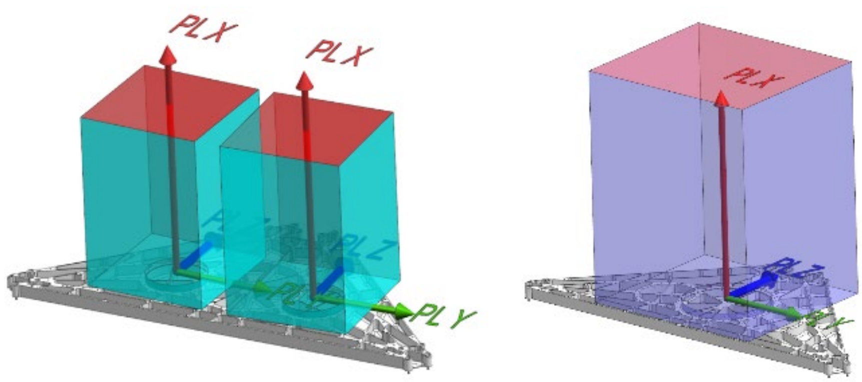

Figure 2-3: Payload $+X_{PL}$ Surface Exit Requirement (red) for Starlink Adapter Configuration

3 ENVIRONMENTS

The Launch Vehicle has been designed to provide a benign Payload environment, via the use of all-liquid propulsion, a single staging event, deeply throttleable engines and pneumatic separation systems. The environments presented below reflect typical mission levels for Payloads; mission-specific analyses will be performed as indicated in the subsequent sections.

3.1 TRANSPORTATION ENVIRONMENTS

Transportation environments will be enveloped by the flight environments in Section 3.3.

3.2 CLEANROOM ENVIRONMENTS

The standard service temperature, humidity and cleanliness environments during various processing phases are provided in Table 3-1.

Conditioned air will only be disconnected for short durations (generally between 30 and 60 minutes) during pre-determined operations such as movements, lifts, and rollout to the pad. Payload environmental temperatures will be maintained above the dew point of the supply air at all times. The SpaceX supplied mechanical interface and fairing surface are cleaned to VC-HS.

Table 3-1: Temperature and Cleanliness Environments

Phase	Control System	Temp °C (°F)	Humidity	Cleanliness (class)
Payload processing	PPF HVAC	21 ± 3 (70 ± 5)	CCAFS/KSC: 45% ± 15% VAFB: 50% ± 15%	100,000 (class 8) or better
Propellant conditioning	Facility HVAC	21 ± 3 (70 ± 5)	CCAFS/KSC: 45% ± 15% VAFB: 50% ± 15%	
Payload propellant loading[1]	Facility HVAC	21 ± 3 (70 ± 5)	CCAFS/KSC: 45% ± 15% VAFB: 50% ± 15%	
Transport to hangar (CCAFS/KSC only)	Transport trailer unit	21 ± 3 (70 ± 5)	0%-60%	
Encapsulated in hangar	Ducted supply from standalone HVAC unit or transport trailer unit (if required)	21 ± 3 (70 ± 5)	CCAFS/KSC: 45% ± 15% VAFB: 50% ± 15%	
Encapsulated roll-out to pad	None (transport trailer unit if required)	n/a	n/a	
Encapsulated on pad (vertical or horizontal)	Pad air conditioning[2]	Bulk air temperature will remain between 10 to 32 (50 to 90), targeting 21 (70)	0% to 65%	

Note:

1. Payload fueling is available as an optional service (see Appendix I) and is not part of the standard Rideshare services.
2. Supply air is switched to GN2 during the Launch Countdown sequence.

3.3 FLIGHT ENVIRONMENTS

The MPEs the Payload will experience from liftoff through separation are described in the sections below. The Launch Vehicle may be able to accommodate Payloads with characteristics outside the limitations indicated in these sections and may also be able to provide environments lower than those indicated in these sections. Please contact SpaceX with your mission-unique requirements.

3.3.1 LOADS

During flight, the Payload will experience a range of axial and bending accelerations. Payload axial and bending mode fundamental frequencies should be greater than 40 Hz. Any deviations to this requirement will need approval and will be subject to increased load factors, to be confirmed via mission-specific analyses. Payload design load factors are listed in Table 3-2 as a function of Payload mass. Linear interpolation should be used to determine load factors for masses not explicitly listed in the table. The load factors defined in Table 3-2 take into account that loads in different axes may occur simultaneously and therefore no additional vector summing needs to be done.

Deployable Payload Constituents, such as MicroSats, as well as the Payload as a whole should be designed to their respective load factors.

- The full Payload should be designed to the load factors defined in Table 3-2 using the total mass of the Payload to derive its load factors.
- Payload Constituents should be designed to the load factors defined in Table 3-2 using the Payload Constituent deployable mass to derive their load factors.

Design load factors do not necessarily bound the random vibration environment described in Section 3.3.5. Payloads should design to both the load factors in Table 3-2 and the random vibration environment in Section 3.3.5. In some instances, the load factors derived from the random vibration environment will be greater than those defined in Table 3-2 and should be accounted for in the Payload design. The random vibration environment should not be notched to stay within the load factors in Table 3-2. Load factors are defined for both dispenser ring and Starlink adapter configurations as defined in Section 4.1.5.

Payload loads are a function of both the Launch Vehicle and Payload structural dynamic properties and are verified via mission-specific CLA. If Payload results are found to exceed the MPE defined in Table 3-2, SpaceX will provide the CLA results to the Customer for further evaluation.

Table 3-2: Rideshare Payload Design Load Factors

Rideshare Load Factors (g)						
Payload Mass (kg)	Dispenser Ring			Starlink Adapter		
	X_{PL}	Y_{PL}	Z_{PL}	X_{PL}	Y_{PL}	Z_{PL}
1	7.4	12.9	12.9	11.4	7.9	7.9
30	7.4	12.8	12.8	11.4	7.9	7.9
100	6.4	12.0	12.0	10.4	7.5	7.5
225	5.5	11.1	11.1	9.5	7.1	7.1
400	5.1	10.3	10.3	9.1	7.0	7.0
600	5.1	9.4	9.4	9.1	7.0	7.0
900	5.1	8.1	8.1	9.1	7.0	7.0

3.3.2 SINE VIBRATION

Sinusoidal vibration levels are not applicable for all Rideshare Payloads. Any Rideshare Payload that is in excess of 225 kg, has secondary structure sensitive below 50Hz or has multiple deploying Payload Constituents should test to the maximum predicted sinusoidal environment listed in Table 3-3 or Table 3-4 as applicable to their mission.

For Payloads with multiple deploying Payload Constituents, the Payload support structure should test to the MPE and the Payload Constituents should only test if they are in excess of 225kg or have secondary structure sensitive below 50Hz. For all other Payloads, random vibration (Section 3.3.5) and loads (Section 3.3.1) will suffice.

The sinusoidal vibration environments represent the levels at the dispenser ring interface or Starlink adapter interface for Q=20 through Q=50, and envelope all stages of flight. If the Payload is using a Q factor lower than 20 please contact

SpaceX with your mission-specific requirements. The sinusoidal environments are defined for both dispenser ring and Starlink adapter configurations as defined in Section 4.1.5.

Table 3-3: Dispenser Ring Maximum Predicted Sinusoidal Vibration Environment

Frequency (Hz)	X_{PL} (g)	Y_{PL} (g)	Z_{PL} (g)
5	1.4	1.5	1.5
45	1.4	1.5	1.5
50	3.0	2.0	2.0
100	3.0	2.0	2.0

Table 3-4: Starlink Adapter Maximum Predicted Sinusoidal Vibration Environment

Frequency (Hz)	X_{PL} (g)	Y_{PL} (g)	Z_{PL} (g)
5	3.0	1.5	1.5
45	3.0	1.5	1.5
50	3.0	2.0	2.0
100	3.0	2.0	2.0

3.3.3 ACOUSTIC

During flight, the Payload will be subjected to a varying acoustic environment. Levels are highest near liftoff and during transonic flight, due to aerodynamic excitation. The acoustic environment, defined as the spatial average and derived at a P95/50 level, is shown by both third-octave (Figure 3-1) and full-octave (Figure 3-2) curves for a typical fill factor of 60%. Margin for qualification testing is not included in the curves below. Figure 3-1 and Table 3-5 provide the third-octave acoustic MPE and Figure 3-2 and Table 3-6 provide the full-octave acoustic MPE for a typical Rideshare Payload.

Customer is responsible for verifying compliance to this requirement. A mission-specific analysis will not be provided by SpaceX.

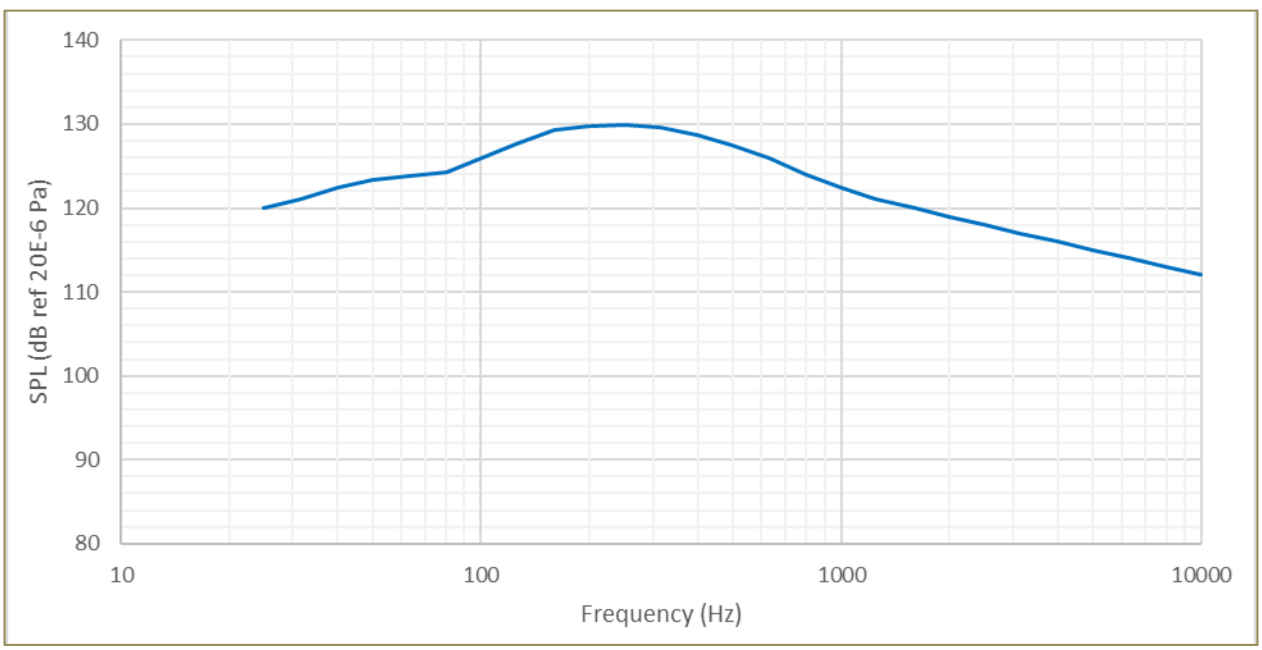

Figure 3-1: Rideshare Payload Maximum Predicted Acoustic Environment (Third Octave)

Table 3-5: Rideshare Payload Maximum Predicted Acoustic Environment (Third Octave)

Frequency (Hz)	Acoustic MPE (P95/50, Space Average, 60% Fill, 4.1 in. Min Clearance)
25	120.0
31.5	121.0
40	122.5
50	123.4
63	123.8
80	124.2
100	125.9
125	127.7
160	129.3
200	129.8
250	129.9
315	129.6
400	128.7
500	127.4
630	126.0
800	124.0
1000	122.5
1250	121.0
1600	120.0
2000	119.0
2500	118.0
3150	117.0
4000	116.0
5000	115.0
6300	114.0
8000	113.0
10000	112.0
OASPL (dB)	139.3

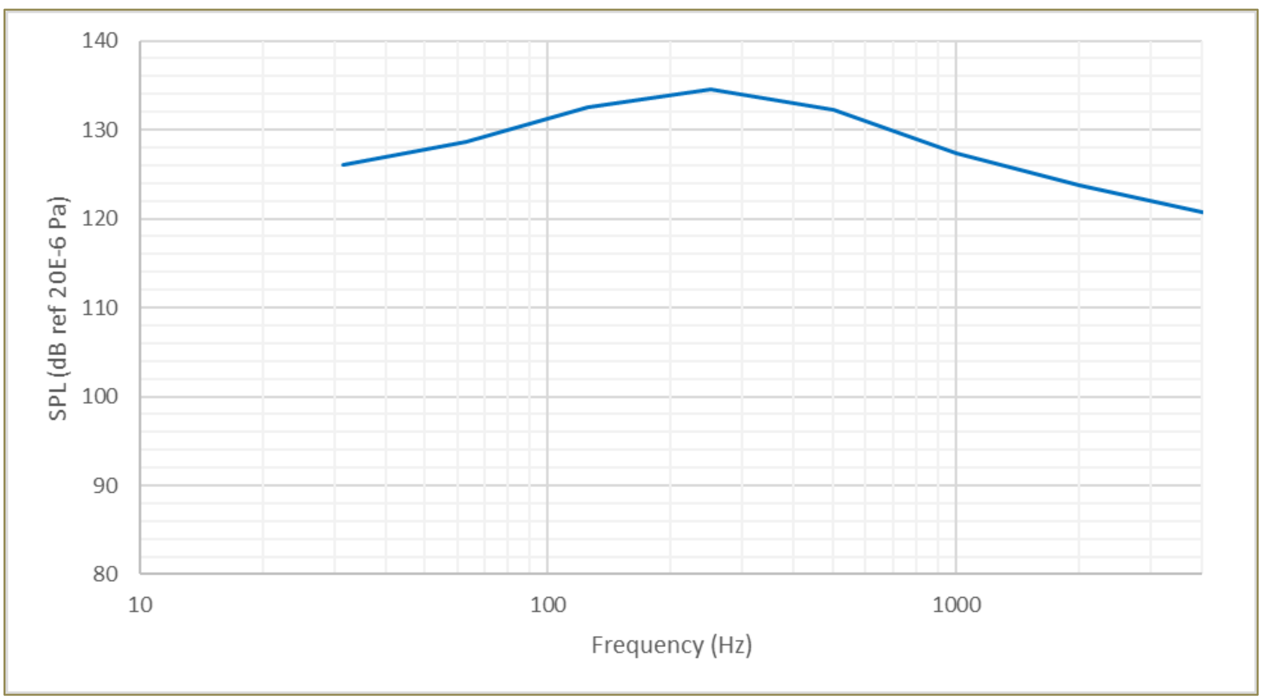

Figure 3-2: Rideshare Payload Maximum Predicted Acoustic Environment (Full Octave)

Table 3-6: Rideshare Payload Maximum Predicted Acoustic Environment (Full Octave)

Frequency (Hz)	Acoustic MPE (P95/50, Space Average, 60% Fill, 4.1 in. Min Clearance)
31.5	126.1
63	128.6
125	132.6
250	134.5
500	132.3
1000	127.4
2000	123.8
4000	120.8
8000	117.8
OASPL (dB)	139.3

3.3.4 SHOCK

The following events during flight result in loads that are characterized as shock loads:

1. Release of the Launch Vehicle hold-down at liftoff
2. Booster and Second Stage separation
3. Fairing deployment
4. Co-Payload separation(s)
5. Payload separation(s)

Of these events, the first two are negligible for the Payload relative to fairing deployment and Payload/Co-Payload(s) separation because of the large distance and number of joints over which the shocks will travel and dissipate. The shock MPE at the Payload mechanical interface for fairing deployment and Co-Payload separation(s) are defined in Figure 3-3 and Table 3-7. This requirement is generated with the assumption that the Payload will be adjacent to a Co-Payload not employing a low-shock separation system.

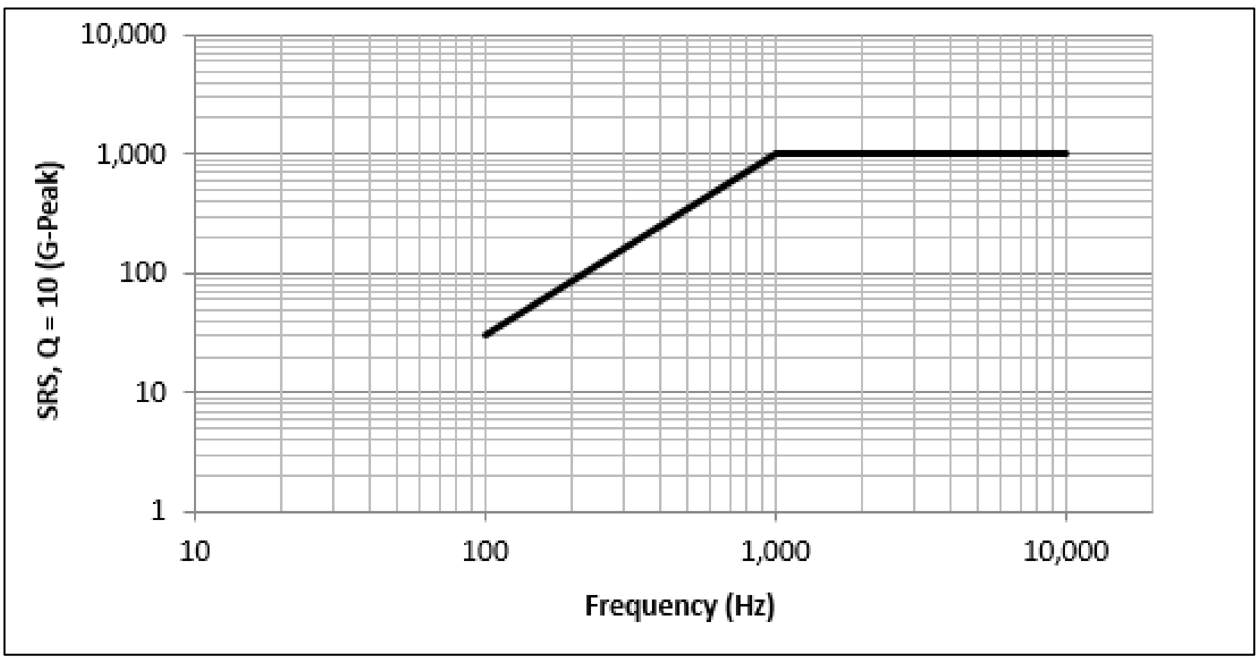

Figure 3-3: Payload Mechanical Interface Shock Induced by Launch Vehicle and Co-Payload(s)

Table 3-7: Payload Mechanical Interface Shock Induced by Launch Vehicle and Co-Payload(s)

Frequency (Hz)	SRS (g)
100	30
1000	1000
10000	1000

Separation systems provided by the Customer must be approved by SpaceX. In most cases, the driving shock load for the Payload will come from the Payload separation system. Shock levels for those systems can be obtained through the separation system manufacturer and/or through Payload unit Shock testing as defined in Section 3.4. The Payload separation shock requirement will be captured in the Payload ICD.

Customer is responsible for verifying compliance to both this requirement and the shock levels obtained through the separation system manufacturer. A mission-specific analysis will not be provided by SpaceX.

3.3.5 RANDOM VIBRATION

The random vibration MPE for the Payload is found in Figure 3-4 and Table 3-8. This MPE is derived from ground testing, flight data, and vibroacoustic models. The smoothline is calculated using flight data from the top of the PAF (see Figure 4-2 for PAF location) and the expected vibration attenuation through the Launch Vehicle hardware to the Payload. The MPE is an envelope of all flight events (liftoff, first stage ascent, and second stage burns) and is derived at a P95/50 statistical level. Note that these levels may not envelope low frequency (<50 Hz) Payload responses; these specific responses can be addressed using CLA if deemed necessary.

Customer is responsible for verifying compliance to this requirement. A mission-specific analysis will not be provided by SpaceX. Random vibration testing per Section 3.4 should occur with the Payload hard-mounted to a shaker table interface. Acceleration response limited or interface force limited testing is acceptable, but will be reviewed by SpaceX for acceptable methodology.

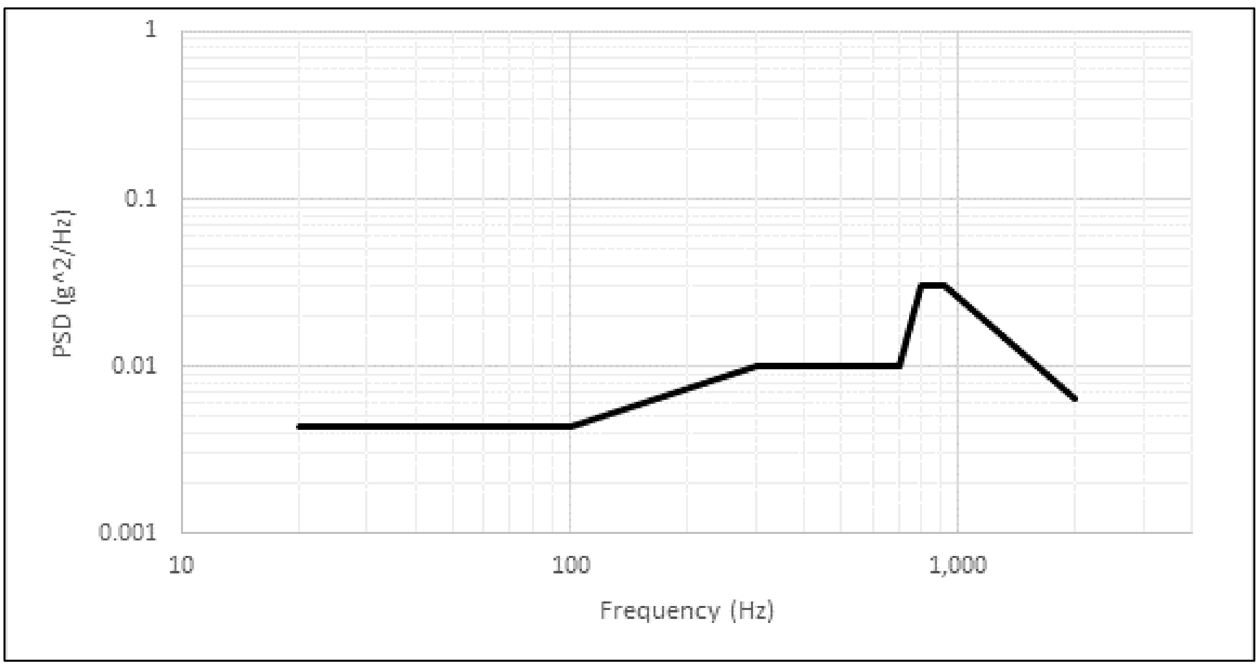

Figure 3-4: Random Vibration MPE

Table 3-8: Random Vibration MPE

Frequency (Hz)	Random Vibration MPE (P95/50), All Axes
20	0.0044
100	0.0044
300	0.01
700	0.01
800	0.03
925	0.03
2000	0.00644
GRMS	5.13

3.3.6 ELECTROMAGNETIC

Customer is responsible for verifying compliance to this requirement. A mission-specific analysis will not be provided by SpaceX for dedicated Rideshare missions. Payload spurious radiated emissions and intentional RF transmitter post-launch activation timeline, as described in Section 3.3.6.3, will be captured in the Payload ICD. Payload radiated susceptibility will be captured in the Payload ICD.

3.3.6.1 RF SYSTEM CHARACTERISTICS

The Launch Vehicle includes several RF systems, which are summarized in Table 3-9.

Table 3-9: Launch Vehicle Transmitter Systems Characteristics

Part Description	Frequency (MHz)
Telemetry Transmitter	2200-2400
Iridium Transmitter	1610 - 1626.5
Co-Payloads	100-40000

3.3.6.2 IN-FLIGHT AND PRE-FLIGHT ENVIRONMENTAL EMISSIONS

Customer must ensure that Payload materials or components sensitive to RF environments are compatible with the worst-case radiated environment shown in Figure 3-5, Table 3-10, and Table 3-11. These limits envelope the expected emissions from the Launch Vehicle, Co-Payloads, and Launch Site radar transmitters. Customer should assume 26dB of shielding from Launch Site sources when testing and integrating the Payload in either the PPF or the Hangar Annex.

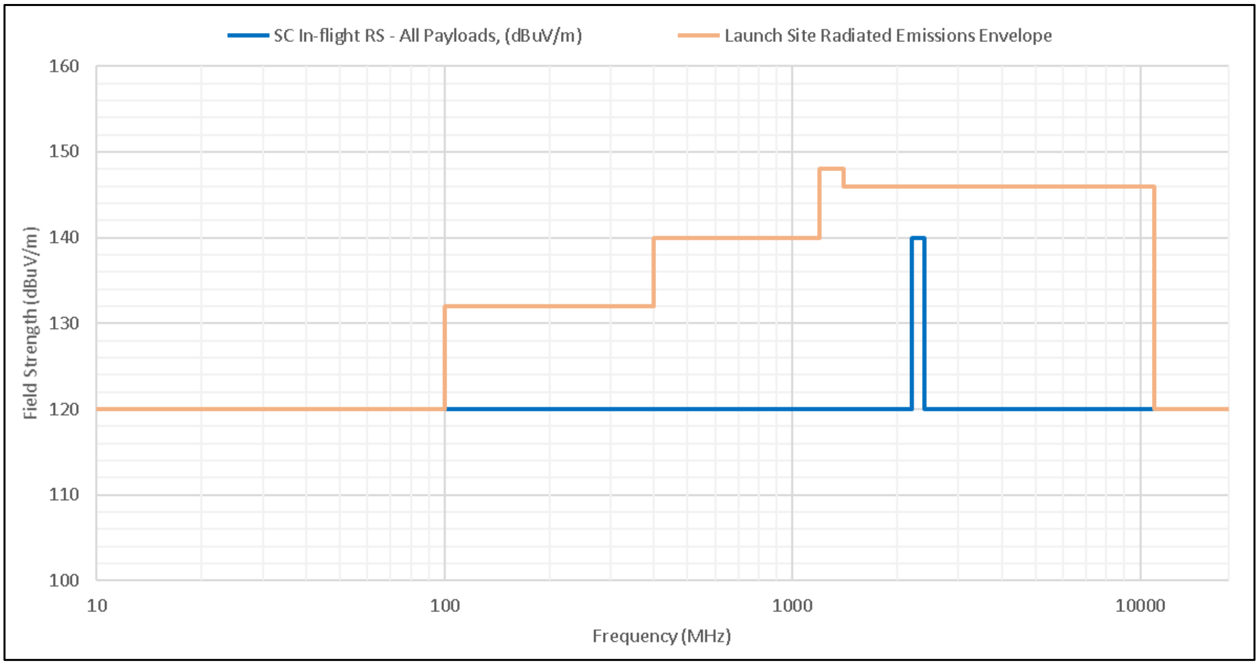

Figure 3-5: In-Flight & Environmental Radiated Emissions / Payload Radiated Susceptibility Limit (EMI Safety Margin not Included)

Table 3-10: Launch Vehicle Radiated Emissions

Frequency Range (MHz)	E-Field Limit (dBµV/m)
1.00 – 2200.0	120
2200.0 – 2300.0	140
2300.0 – 18000.0	120

Table 3-11: Launch Site Radiated Emissions

Frequency Range (MHz)	E-Field Limit (dBµV/m)
1.00 – 100	120
100 – 400	132
400 – 1200	140
1200 – 1400	148
1400 – 11000	146
11000 – 18000	120

3.3.6.3 MAXIMUM PAYLOAD EMISSIONS

The maximum emissions from multiple Rideshare sources estimated at the surface of Co-Payloads, in combination with a special consideration for GPS navigation frequencies, is used as the requirement for maximum allowable individual Payload emissions, including spurious emissions. The emission envelope for dedicated Rideshare missions and Secondary Rideshare missions, including 6dB of EMI safety margin by test or 12dB of EMI safety margin by analysis, is shown in Figure 3-6 and Table 3-14. Customers should note that there exists a notch in the payload emissions spectrum around GPS (1575.42 +/- 20MHz) at a level of 48dBuV/m.

Payload spurious emissions during launch must show compliance with this requirement by test or by analysis. Verification by test may be performed in-house per MIL-STD-461, with supporting test documentation or obtained from an IEC-17025 accredited (or equivalent) test facility. Verification by analysis may be achieved by (a) providing analysis of battery power isolation, leakage, and power-on inhibit strategy or (b) electromagnetic circuit and wiring emissions analysis showing 12dB of EMI safety margin to the emissions limit (as captured in Table 3-14).

Standard Launch services do not permit use of Payload transmitters while integrated to the Launch Vehicle hardware. Payload transmitters may be enabled after the time interpolated using the information found in Table 3-12 for dedicated Rideshare missions and Table 3-13 for Secondary Rideshare missions.

Table 3-12: Dedicated Rideshare Mission Transmitter Delay Time (seconds)

	EIRP (Watts)	0.00001	0.0001	0.001	0.01	0.1	1	10	19.95	100	1000
	EIRP (dBm)	-20	-10	0	10	20	30	40	43	50	60
Separation Velocity (m/s)	0.1	0.17	0.55	1.73	5.48	17.32	54.77	173.21	244.66	547.72	1732.05
	0.2	0.09	0.27	0.87	2.74	8.66	27.39	86.60	122.33	273.86	866.03
	0.5	0.03	0.11	0.35	1.10	3.46	10.95	34.64	48.93	109.54	346.41
	1.0	0.02	0.05	0.17	0.55	1.73	5.48	17.32	24.47	54.77	173.21
	2.0	0.01	0.03	0.09	0.27	0.87	2.74	8.66	12.23	27.39	86.60
	5.0	0.00	0.01	0.03	0.11	0.35	1.10	3.46	4.89	10.95	34.64

Table 3-13: Secondary Rideshare Mission Transmitter Delay Time (seconds)

	EIRP (Watts)	0.00001	0.0001	0.001	0.01	0.1	1	10	19.95	100	1000
	EIRP (dBm)	-20	-10	0	10	20	30	40	43	50	60
Separation Velocity (m/s)	0.1	5.48	17.32	54.77	173.21	547.72	1732.05	5477.23	7736.79	17320.51	54772.26
	0.2	2.74	8.66	27.39	86.60	273.86	866.03	2738.61	3868.39	8660.25	27386.13
	0.5	1.10	3.46	10.95	34.64	109.54	346.41	1095.45	1547.36	3464.10	10954.45
	1.0	0.55	1.73	5.48	17.32	54.77	173.21	547.72	773.68	1732.05	5477.23
	2.0	0.27	0.87	2.74	8.66	27.39	86.60	273.86	386.84	866.03	2738.61
	5..0	0.11	0.35	1.10	3.46	10.95	34.64	109.54	154.74	346.41	1095.45

These requirements assume the worst-case transmitter antenna gain is in the direction of the Launch Vehicle; Customers may provide verification by analysis of the attitude control and off-boresight antenna gain arguments to reduce the turn-on time if desired.

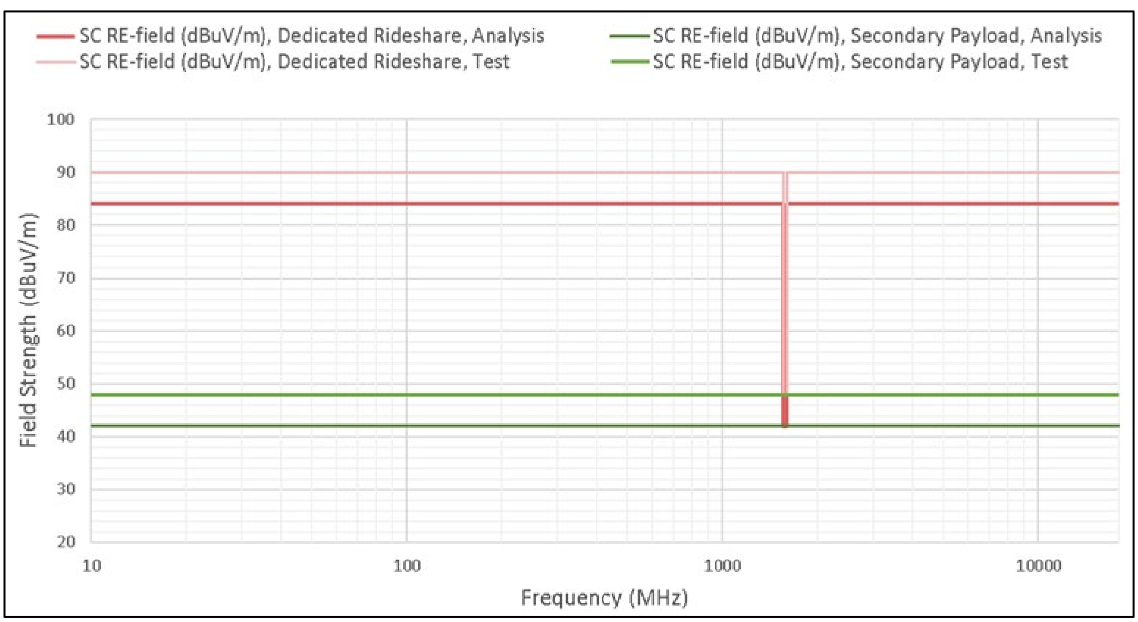

Figure 3-6: Maximum Payload Emissions

Table 3-14: Maximum Payload Emissions

Frequency Range (MHz)	Dedicated Rideshare by Test (dBμV/m)	Dedicated Rideshare by Analysis (dBμV/m)	Secondary Rideshare by Test (dBμV/m)	Secondary Rideshare by Analysis (dBμV/m)
30.0 – 1555.42	90	84	48	42
1555.42 – 1595.42	48	42	48	42
30.0 – 18000.0	90	84	48	42

3.3.6.4 EMI SAFETY MARGIN

To account for unexpected variation in hardware and environments, EMI safety margin is required for Customer compatibility. EMI safety margin is typically expected to be included on the "victim" side of the source-victim analysis. EMI safety margin (6dB by test, 12dB by analysis) is included in the Payload emissions requirements defined in Section 3.3.6.3. It is expected that the relevant Payload immunity analysis/test will include the appropriate EMI safety margin when Customer evaluates compatibility to Section 3.3.6.2.

3.3.6.5 LIGHTNING PROTECTION

All SpaceX integration facilities and hangars are equipped with NFPA-780 compliant lightning rod and current distribution networks to protect personnel and hardware from lightning. The SpaceX launch pads at CCAFB/KSC (SLC-40 and LC-39A) are equipped with overhead wire lightning protection systems to protect the launch vehicle and payload from a direct lightning attachment. The SpaceX launch pad at VAFB uses operational mitigations in the event of a lightning risk due to the low likelihood of lightning at VAFB.

3.3.6.6 LIGHTNING RETEST

Well-defined lightning retest criteria and associated verification processes are important to quickly check for damage of flight critical sensors/actuators and maximize Launch opportunities. As such, SpaceX will perform verification tests and inform the Customer in the event of a lightning strike with an amplitude ≥ 40kA occurring within a half nautical mile of the Launch Vehicle. The lightning strike amplitude and location data can be obtained from Range-provided lightning monitoring systems or from the National Lightning Data Network.

3.3.7 FAIRING INTERNAL PRESSURE

Inside the Launch Vehicle, the fairing internal pressure will decay at a rate no larger than 0.40 psi/sec (2.8 kPa/sec) from liftoff through immediately prior to fairing separation, except for brief periods during flight, where the fairing internal pressure will decay at a rate no larger than 0.65 psi/sec (4.5 kPa/sec), for no more than 5 seconds.

3.3.8 PAYLOAD TEMPERATURE EXPOSURE DURING FLIGHT

The Launch Vehicle fairing is a composite structure consisting of a 1.9 cm (0.75 in.) thick aluminum honeycomb core surrounded by carbon fiber face sheet plies. The emissivity of the fairing is approximately 0.9. The fairing thermal insulation, which is attached to the outside of the fairing composite, is sized such that the composite never exceeds the bounding fairing composite temperature profile shown in Figure 3-7. The curve is truncated at 240 seconds. Fairing jettison timing is determined by SpaceX for each mission.

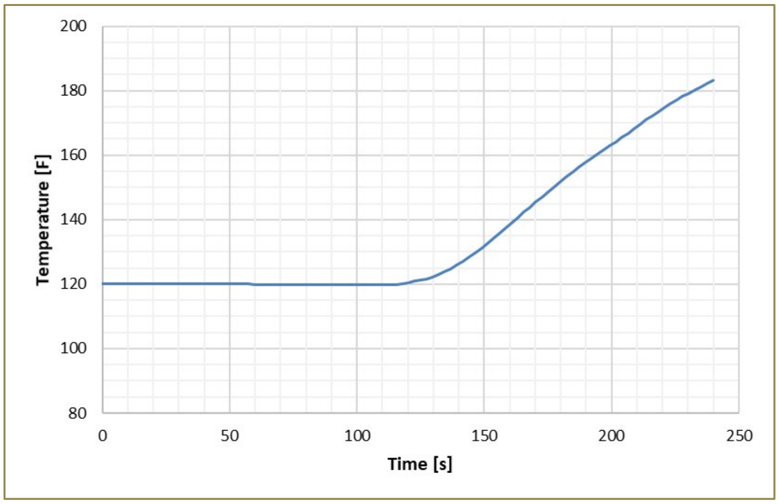

Figure 3-7: Maximum Fairing Spot Temperature Seen by Rideshare Payload

3.3.9 FREE MOLECULAR HEATING

The fairing will nominally be deployed when free molecular aero-thermal heating is less than 3,500 W/m^2.

3.3.10 PAYLOAD CONDUCTIVE BOUNDARY TEMPERATURES

Bounding hot and cold boundary temperatures and conductance values at the interface of the Payload and the Mechanical Interface Ring are shown below in Table 3-15 and Figure 3-8.

Customer is responsible for using these boundary conditions to run a Payload-specific thermal analysis. A mission-specific analysis will not be provided by SpaceX.

Table 3-15: Bounding Hot and Cold Conductive Boundary Condition for Rideshare Payloads in Flight

Time (s)	Hot Temperature (°C)	Cold Temperature (°C)	Min Conductance (W/°C)	Max Conductance (W/°C)
0	40	-5	0	7.7
1000	42	-10	0	7.7
2000	52	-15	0	7.7
3000	52	-20	0	7.7
7200	52	-20	0	7.7

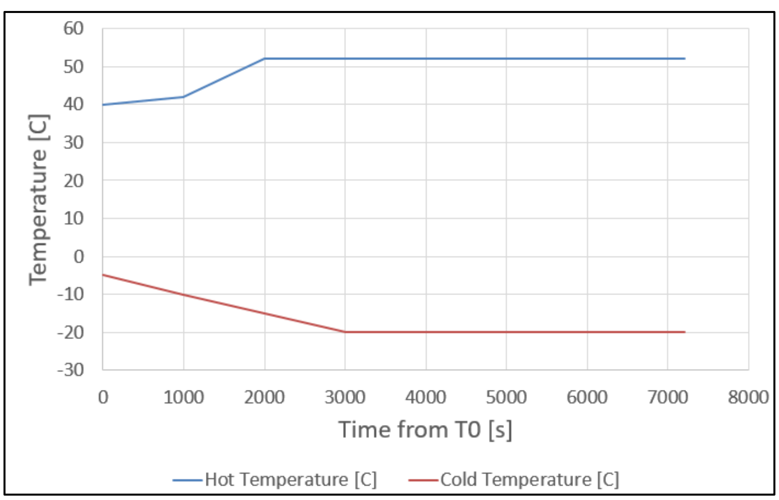

Figure 3-8: Bounding Conductive Boundary Temperature

3.3.11 CONTAMINATION

SpaceX contamination control is described in Section 3.2. Payload contamination must fall within the requirements found in Table 3-16.

Customer is responsible for verifying compliance to this requirement in the form of a Payload contamination report, submitted for SpaceX review addressing the items listed in Table 3-16. A mission-specific analysis will not be provided by SpaceX.

Table 3-16: Payload Contamination Requirements

Name	Description
Visual Cleanliness	Payloads must be cleaned to VC-HS standards per NASA-SN-C-005D prior to integration onto Launch Vehicle hardware.
Non-Metallic Materials	Non-metallic materials used in the construction of the Payload that will be exposed to vacuum must not exceed a total mass loss of 1.0% and the volatile condensable matter must be less than 0.1% when tested per ASTM E595. A complete vacuum-exposed non-metallic materials list including quantities (surface area or mass) will be delivered to SpaceX for review. Any exceedances will be evaluated and approved on a case-by-case basis.
Metallic Materials	The selection of metallic materials by the Customer will include consideration of corrosion, wear products, shedding, and flaking in order to reduce particulate contamination. Dissimilar metals in contact will be avoided unless adequately protected against galvanic corrosion.
Payload Particulate Generation	The Payload will not create particulate during the vibroacoustic ascent environment. Actuation of any Payload mechanisms nearby any Co-Payload(s) or Launch Vehicle Hardware must not create particulate.
Payload Deployment	The Payload deployment system will not include the use of uncontained pyrotechnics (e.g. Frangible nuts).
Payload Propulsion	Payload propulsion systems will not be operated in close proximity (within 1km) of Co-Payload(s).
Prohibited Materials	The following materials are not to be used on Payload hardware: • cadmium parts • cadmium-plated parts • zinc plating • mercury, compounds containing mercury • pure tin or tin electroplate (except when alloyed with lead, antimony, or bismuth)
Silicone Sensitivity	All silicone rubber or RTV silicones with probability of transfer to Co-Payload(s) or Launch Vehicle hardware will require SpaceX approval, coordination, and notification prior to use.

3.4 ENVIRONMENTAL VERIFICATION TESTING

Prior to launch, SpaceX requires that Customer verifies the compatibility of their Payload with the Launch Vehicle's flight MPEs found in Section 3.3. Environmental testing for Payloads must be performed by either:

1. A Fleet Qualification Approach
    a. Qualification testing levels on a qualification unit followed by
    b. Acceptance testing levels on flight units

OR

2. A Single Unit Approach
    a. Protoqualification testing on the flight unit

3.4.1 PAYLOAD UNIT TEST LEVELS

Payload unit testing must conform to the parameters shown in Table 3-17. Deviations may be acceptable but must be reviewed and approved by SpaceX. Tests that are "Advised" are designed to ensure on-orbit health and functionality of the Payload but are not required in order to fly on a SpaceX Rideshare Mission. Tests that are "Required" must be completed by the Customer. Variations for containerized CubeSats and purely metallic structures are found in Section 3.4.2 and Section 3.4.3 respectively.

Customer must deliver to SpaceX a summary of the verification methodology used as well as test reports for all completed testing described in Table 3-17. If Customer chooses not to complete any "Advised" tests then Customer will be required to submit a letter to SpaceX verifying that they are willing to take on the inherent risks to the Payload by not completing the "Advised" Payload unit testing.

Table 3-17: Payload Unit Test Levels and Durations

Test	Fleet Qualification Approach		Single unit Approach	Required or Advised
	Qualification	Acceptance	Protoqualification	
Shock	6 dB above MPE, 3 times in each of 3 orthogonal axes	Not Required	3 dB above MPE, 2 times in each of 3 orthogonal axes	Required
Acoustic	6 dB above acceptance for 2 minutes	MPE spectrum for 1 minute	3 dB above acceptance for 1 minutes [1]	Advised
Random Vibration	6 dB above acceptance for 2 minutes in each of 3 axes	MPE spectrum for 1 minute in each of 3 axes	3 dB above acceptance for 1 minutes in each of 3 axes	Required
Combined Thermal Vacuum and Thermal Cycle [2]	±10°C beyond acceptance for 27 cycles total	Envelope of MPT and minimum range (–24 to 61°C) for 14 cycles total	±5°C beyond acceptance for 20 cycles total	Advised
Static Load [3]	1.25 times the limit load	1.1 times the limit load	1.25 times the limit load	Required
Sinusoidal Vibration	1.25 times limit levels, two octave/minute sweep rate in each of 3 axes	1.0 times limit levels, four octave/minute sweep rate in each of 3 axes [4]	1.25 times limit levels, two octave/minute sweep rate in each of 3 axes	Required [5]
Pressure	Pressures as specified in Table 6.3.12-2 of SMC-S-016 following acceptance proof pressure test, duration sufficient to collect data	1.25 times MEOP for pressure vessels; 1.5 times MEOP for pressure components. Other metallic pressurized hardware items per References 4 and 5 from SMC-S-016	Not Applicable at the Payload Level [6]	Required
Electromagnetic Compatibility [7,8]	6dB EMISM by Test and/or 12dB EMISM by Analysis	Not Applicable	6dB EMISM by Test and/or 12dB EMISM by Analysis	Required

Notes:

1. Single-unit acoustic testing approach uses test levels and a test duration consistent with NASA 7001/7005 Proto-flight testing.
2. Thermal cycles can be accrued as a combination of thermal cycling in air and thermal vacuum, it is recommended to include at least four cycles of thermal vacuum unless strong rationale exists that the Payload is not sensitive to vacuum.
3. Static Load testing can be achieved through a sine-burst test. Loads may occur simultaneously, so the test should ensure the structure will sustain the total combined loads. In some instances, Random Vibration testing at the levels described in this table may surpass the static load factors. When this is the case, it is acceptable to omit static load testing.
4. Sinusoidal Vibration acceptance testing is required if the Payload's axial or bending mode fundamental frequencies are below 40 Hz. Testing may be bypassed if the Payload's axial and bending mode fundamental frequencies are above 40 Hz and the Payload performs the acceptance Random Vibration test to the levels described in this table.
5. Sinusoidal Vibration testing is only required if the Payload is subject to sinusoidal vibration loads as defined in Section 3.3.2.

6. Pressure systems cannot be protoqualified at the Payload level. Pressure systems must therefore be qualified via the fleet qualification approach at the component level. Supplier qualification testing is acceptable in place of fleet level qualification testing if approved by SpaceX.
7. Verification by test may be performed in-house per MIL-STD-461 with supporting test documentation or obtained from an IEC-17025 accredited (or equivalent) test facility. Verification by analysis must provide (1) a battery isolation inhibit strategy or (2) electromagnetic circuit and wiring emissions analysis. For some Rideshare configurations (such as SC with GPS receivers), verification by analysis may be achieved through demonstration of self-compatibility with on-board GPS navigation systems.
8. EMISM (6dB by test, 12dB by analysis) is already included in Table 3-17.

3.4.2 CONTAINERIZED CUBESAT UNIT TEST LEVELS

Table 3-18 can be used for CubeSat payload unit test levels and durations provided that the CubeSat is fully containerized. CubeSats utilizing deployment devises that are not fully containerized do not fall within this modification. This section does not apply to the CubeSat deployment device itself.

Table 3-18: Containerized CubeSat Unit Test Levels and Durations

Test	Fleet Qualification Approach		Single unit Approach	Required or Advised
	Qualification	Acceptance	Protoqualification	
Shock	6 dB above MPE, 3 times in each of 3 orthogonal axes	Not Required	3 dB above MPE, 2 times in each of 3 orthogonal axes	Advised
Acoustic	n/a	n/a	n/a	n/a
Random Vibration	3 dB above acceptance for 2 minutes in each of 3 axes	MPE spectrum for 1 minute in each of 3 axes	MPE spectrum for 1 minute in each of 3 axes	Required
Combined Thermal Vacuum and Thermal Cycle [1]	±10°C beyond acceptance for 27 cycles total	Envelope of MPT and minimum range (–24 to 61°C) for 14 cycles total	±5°C beyond acceptance for 20 cycles total	Advised
Static Load [2]	1.25 times the limit load	1.1 times the limit load	1.25 times the limit load	Advised
Sinusoidal Vibration	n/a	n/a	n/a	n/a
Pressure	Pressures as specified in Table 6.3.12-2 of SMC-S-016 following acceptance proof pressure test, duration sufficient to collect data	1.25 times MEOP for pressure vessels; 1.5 times MEOP for pressure components. Other metallic pressurized hardware items per References 4 and 5 from SMC-S-016	Not Applicable at the Payload Level [3]	Required
Electromagnetic Compatibility [4,5]	6dB EMISM by Test and/or 12dB EMISM by Analysis	Not Applicable	6dB EMISM by Test and/or 12dB EMISM by Analysis	Required

Notes:

1. Thermal cycles can be accrued as a combination of thermal cycling in air and thermal vacuum, it is recommended to include at least four cycles of thermal vacuum unless strong rationale exists that the Payload is not sensitive to vacuum.
2. Static Load testing can be achieved through a sine-burst test. Loads may occur simultaneously, so the test should ensure the structure will sustain the total combined loads. In some instances, Random Vibration testing at the levels described in this table may surpass the static load factors. When this is the case, it is acceptable to omit static load testing.
3. Pressure systems cannot be protoqualified at the Payload level. Pressure systems must therefore be qualified via the fleet qualification approach at the component level. Supplier qualification testing is acceptable in place of fleet level qualification testing if approved by SpaceX.
4. Verification by test may be performed in-house per MIL-STD-416, with supporting test documentation or obtained from an IEC-17025 accredited (or equivalent) test facility. Verification by analysis must provide (1) a battery isolation inhibit strategy, or (2) electromagnetic circuit and wiring emissions analysis, or (3) dispenser shielding information showing margin to

requirement. For some Rideshare configurations, verification by analysis may be achieved through demonstration of self-compatibility with on-board GPS navigation systems.

5. EMISM (6dB by test, 12dB by analysis) is already included in Table 3-18.

3.4.3 METALLIC STRUCTURE UNIT TEST LEVELS

Table 3-19 can be used for metallic structure unit test levels and durations.

Table 3-19: Metallic Structure Unit Test Levels and Durations

Test	Fleet Qualification Approach		Single unit Approach	Required or Advised
	Qualification	Acceptance	Protoqualification	
Shock	n/a	n/a	n/a	n/a
Acoustic	6 dB above acceptance for 2 minutes	MPE spectrum for 1 minute	3 dB above acceptance for 1 minutes [1]	Advised
Random Vibration	6 dB above acceptance for 2 minutes in each of 3 axes	MPE spectrum for 1 minute in each of 3 axes	3 dB above acceptance for 1 minutes in each of 3 axes	Advised
Combined Thermal Vacuum and Thermal Cycle	n/a	n/a	n/a	n/a
Static Load [2]	1.25 times the limit load and/or by Analysis [3]	1.1 times the limit load [4]	1.25 times the limit load	Required
Sinusoidal Vibration	1.25 times limit levels, two octave/minute sweep rate in each of 3 axes	1.0 times limit levels, four octave/minute sweep rate in each of 3 axes [5]	1.25 times limit levels, two octave/minute sweep rate in each of 3 axes	Advised [6]
Pressure	n/a	n/a	n/a	n/a
Electromagnetic Compatibility	n/a	n/a	n/a	n/a

Notes:

1. Single-unit acoustic testing approach uses test levels and a test duration consistent with NASA 7001/7005 Proto-flight testing.
2. Static Load testing can be achieved through a sine-burst test. Loads may occur simultaneously, so the test should ensure the structure will sustain the total combined loads. In some instances, Random Vibration testing at the levels described in this table may surpass the static load factors. When this is the case, it is acceptable to omit static load testing
3. Metallic structures may be designed to no-test factors of safety (no failure at 2.0 times the limit load) and use analysis-only qualification if load paths are simple and deterministic.
4. Acceptance testing may be bypassed on metallic structures that do not have workmanship sensitive processes (welding, bonding, curing, forging or casting).
5. Sinusoidal Vibration acceptance testing is required if the Payload's axial or bending mode fundamental frequencies are below 40 Hz. Testing may be bypassed if the Payload's axial and bending mode fundamental frequencies are above 40 Hz and the Payload performs the acceptance Random Vibration test to the levels described in this table.
6. Sinusoidal Vibration testing only applies if the Payload is subject to sinusoidal vibration loads as defined in Section 3.3.2.

4 INTERFACES

4.1 MECHANICAL INTERFACES

4.1.1 LAUNCH VEHICLE COORDINATE FRAME

The Launch Vehicle uses a right-hand X-Y-Z coordinate frame, indicated with the subscript "LV", centered 440.69 cm (173.5 in.) aft of the first-stage radial engine gimbal, with $+X_{LV}$ aligned with the vehicle long axis and $+Z_{LV}$ opposite the TE strongback (Figure 4-1). X_{LV} is the roll axis, Y_{LV} is the pitch axis, and Z_{LV} is the yaw axis.

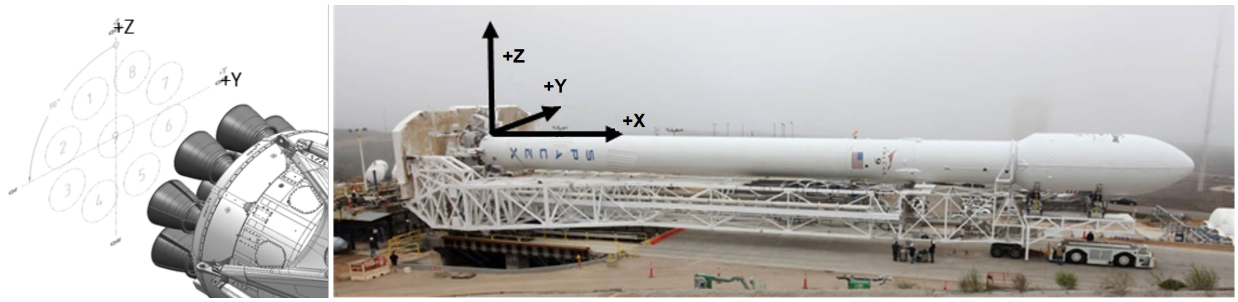

Figure 4-1: Launch Vehicle Coordinate Frame

4.1.2 LAUNCH VEHICLE FAIRING

The Launch Vehicle fairing is 5.2 m (17.2 ft.) in outer diameter and 13.2 m (43.5 ft.) high overall. The total available volume shared by both Payload and Co-Payload(s) is shown in Figure 4-2. All processing requiring access to the Payload must be completed prior to fairing encapsulation including remove/install-before-flight items.

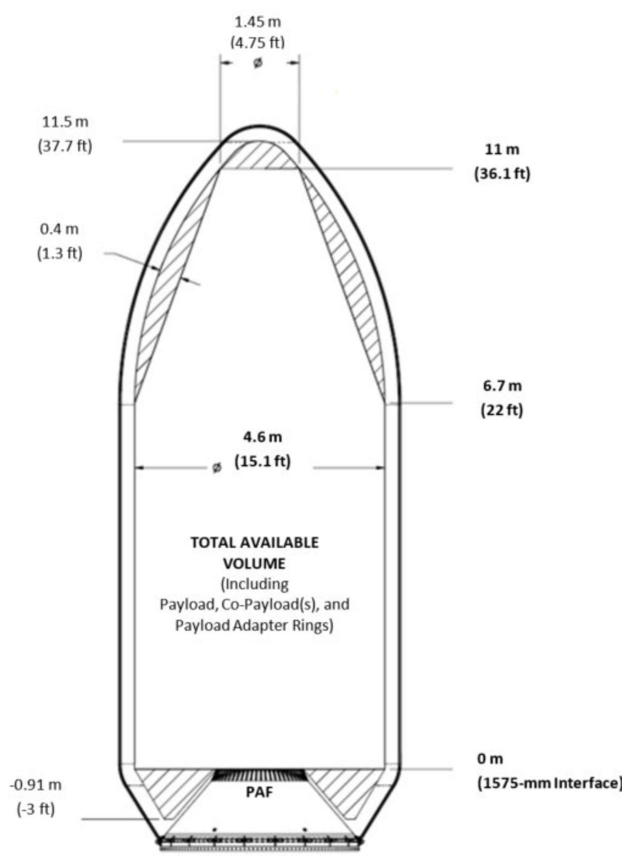

Figure 4-2: Total Available Fairing Volume

4.1.3 PAYLOAD COORDINATE FRAME

The Payload will utilize a right-hand X-Y-Z coordinate system, indicated with a subscript "PL" with X_{PL} in the Payload axial direction, see Section 4.1.5 for examples. The origin of the Payload coordinate system is fixed at the center of the mechanical interface between Customer-supplied hardware and SpaceX supplied hardware.

4.1.4 MECHANICAL INTERFACE RING

The standard mechanical interface between SpaceX-provided Launch Vehicle hardware and the Customer-provided hardware is either a 15" or a 24" diameter interface via a SpaceX-provided Mechanical Interface Ring. The Mechanical Interface Ring can accommodate Payload mechanical attachments with either threaded inserts or thru-holes. Non-standard mechanical interface diameters can be accommodated by using an adapter plate provided by SpaceX as an optional service (see Appendix I). The SpaceX-provided Mechanical Interface Ring is not included in the allowable Payload Volume described in Section 4.1.5. Customer is responsible for providing the Payload side fasteners with two forms of retention to mate the Mechanical Interface Ring to the Payload; Customer is also responsible for the structural analysis for their chosen fasteners at that interface. It is preferred for the fastener secondary retention method to create running resistance without torque being present and being verifiable (no Loctite or lock-washers). SpaceX is responsible for the final mate to the Launch Vehicle hardware.

4.1.4.1 15" MECHANICAL INTERFACE RING (INSERTS)

The 15" diameter Mechanical Interface Ring for Payload-side threaded inserts is shown in Figure 4-3 (with and without fasteners). In this configuration, the Payload will mechanically interface to the Launch Vehicle hardware via twenty-four 0.25" diameter 28TPI fasteners as shown in Figure 4-4. Detailed dimensions can be found in Figure A-1 in Appendix A.

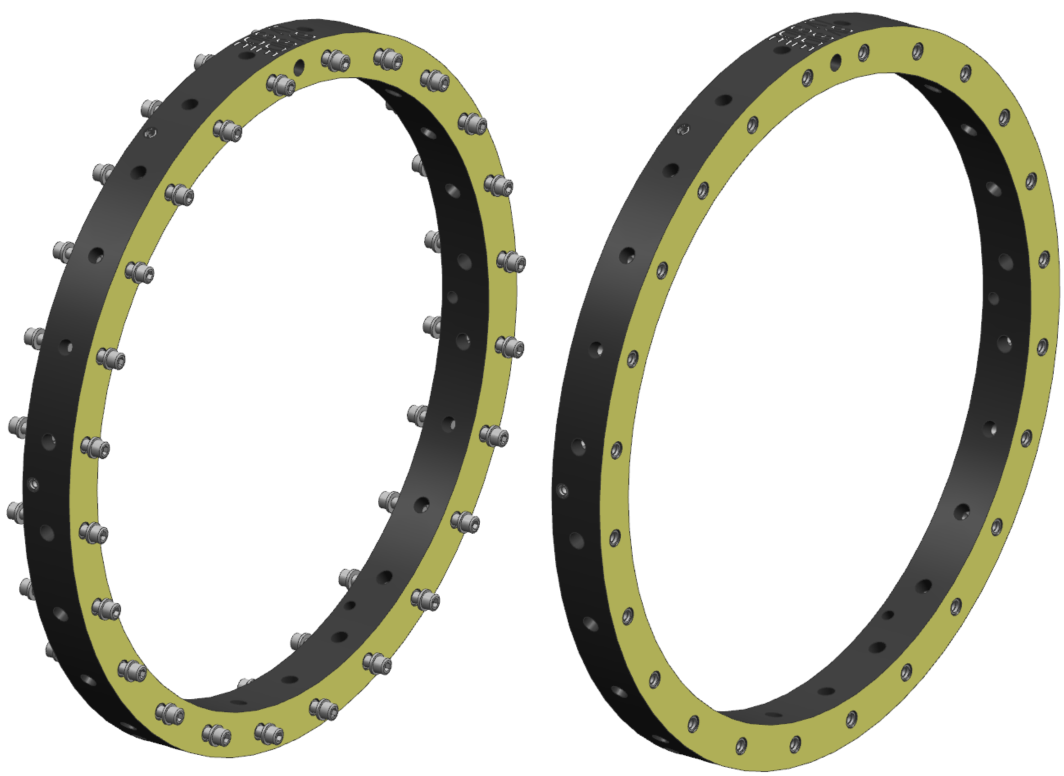

Figure 4-3: 15" Diameter Mechanical Interface Ring (Inserts)

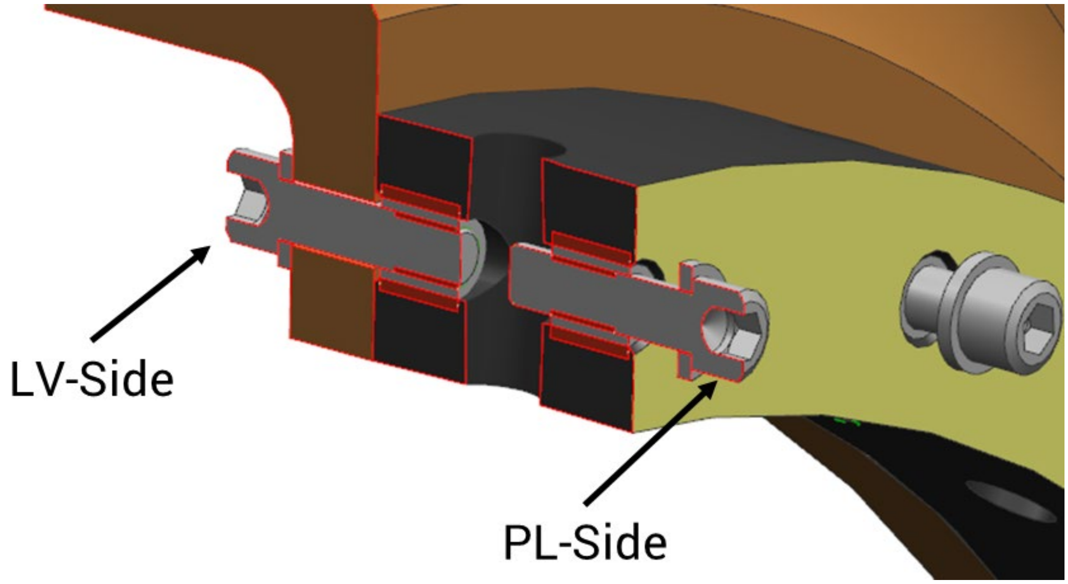

Figure 4-4: Mechanical Interface Ring (Inserts) Assembly to Launch Vehicle Hardware

4.1.4.2 15" MECHANICAL INTERFACE RING (THRU-HOLES)

The 15" diameter Mechanical Interface Ring for Payload-side thru-holes is shown in Figure 4-5 (with and without fasteners). In this configuration, the Payload will mechanically interface to the Launch Vehicle hardware via twenty-four 0.272" diameter thru-holes as shown in Figure 4-6. Detailed dimensions can be found in Figure A-2 in Appendix A.

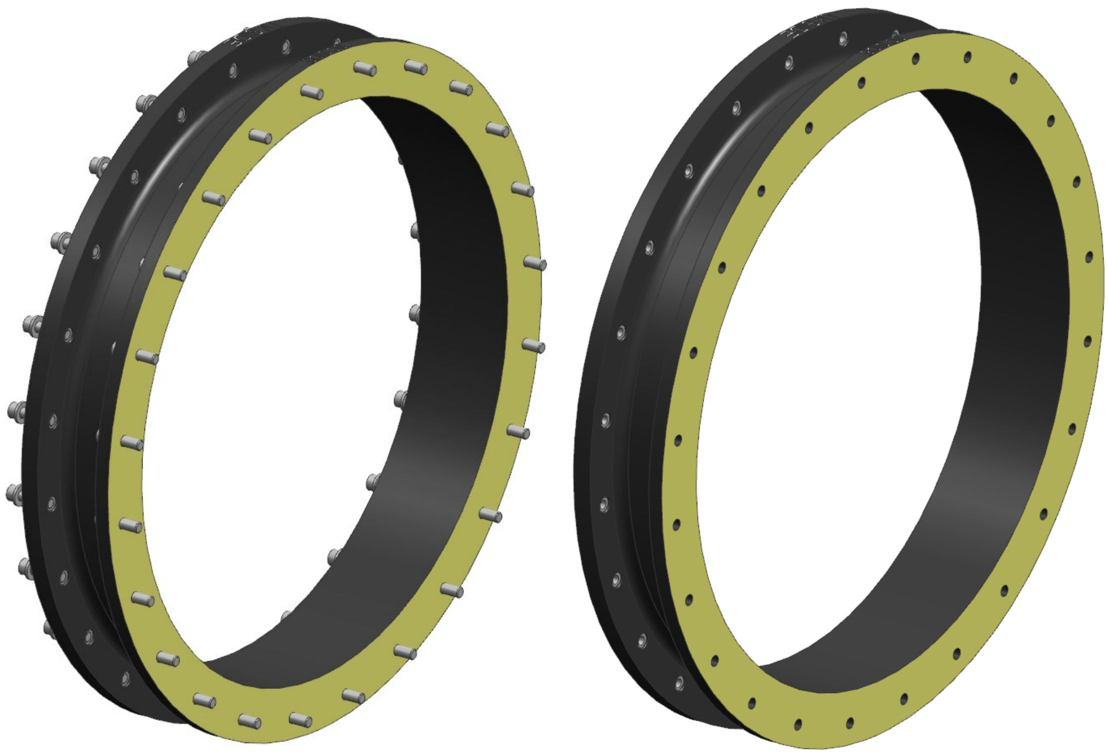

Figure 4-5: 15" Diameter Mechanical Interface Ring (Thru-Holes)

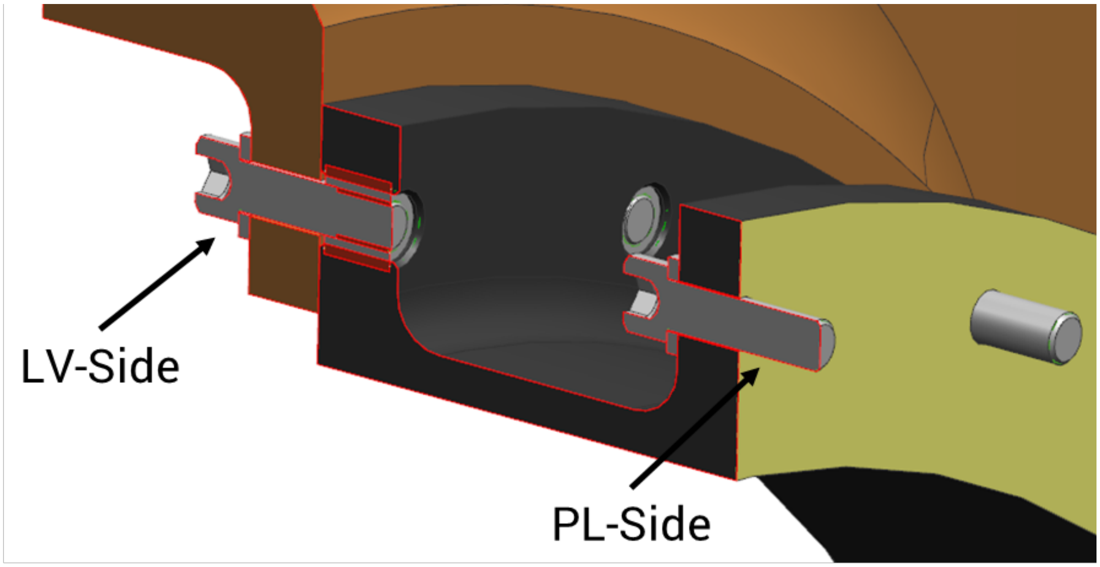

Figure 4-6: Mechanical Interface Ring (Thru-Holes) Assembly to Launch Vehicle Hardware

4.1.4.3 24" MECHANICAL INTERFACE RING (INSERTS)

The 24" diameter Mechanical Interface Ring for Payload-side threaded inserts is shown in Figure 4-7 (with and without fasteners). In this configuration, the Payload will mechanically interface to the Launch Vehicle hardware via thirty-six 0.25" diameter 28TPI fasteners using the same integration process as shown in Figure 4-4. Detailed dimensions can be found in Figure A-3 in Appendix A.

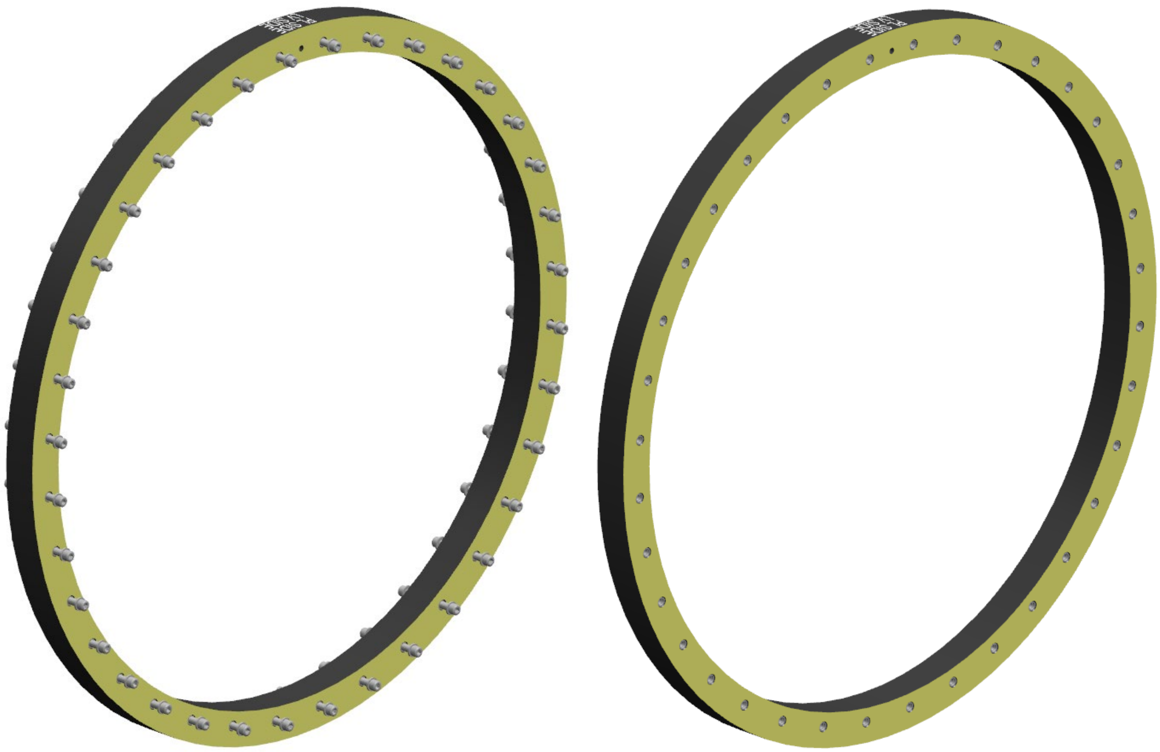

Figure 4-7: 24" Diameter Mechanical Interface Ring (Inserts)

4.1.4.4 24" MECHANICAL INTERFACE RING (THRU-HOLES)

The 24" diameter Mechanical Interface Ring for Payload-side thru-holes is shown in Figure 4-8 (with and without fasteners). In this configuration, the Payload will mechanically interface to the Launch Vehicle hardware via thirty-six 0.272" diameter thru-holes using the same integration process as shown in Figure 4-6. Detailed dimensions can be found in Figure A-4 in Appendix A.

Figure 4-8: 24" Diameter Mechanical Interface Ring (Thru-Holes)

4.1.5 PAYLOAD AVAILABLE VOLUME

The Payload must be no larger than the available volume defined in the following sections depending on the launch configuration and mechanical interface diameter. Depending on the Mission, SpaceX will inform Customer whether the Payload will be on a Rideshare dispenser ring (horizontal when the Launch Vehicle is vertical on the Launch pad) or Starlink adapter (vertical when the Launch Vehicle is vertical on the Launch pad) interface. Customer may request small dimension changes to this volume and SpaceX will reasonably consider whether the Launch Services can support such changes with minimal additional work or risks to the Mission.

4.1.5.1 DISPENSER RING 15" MECHANICAL INTERFACE

The dispenser ring (side-mounted) 15" diameter mechanical interface allowable volume is shown in Figure 4-9 with a base of 34" (Z_{PL}) by ~33" (Y_{PL}) and a 60-degree cone extending ~56" in the X_{PL} direction. In addition, there is an allowable 7" intrusion through the Mechanical Interface Ring. Detailed dimensions can be found in Figure A-5 in Appendix A. Each 15" variant of the dispenser ring can accommodate six Rideshare Payloads.

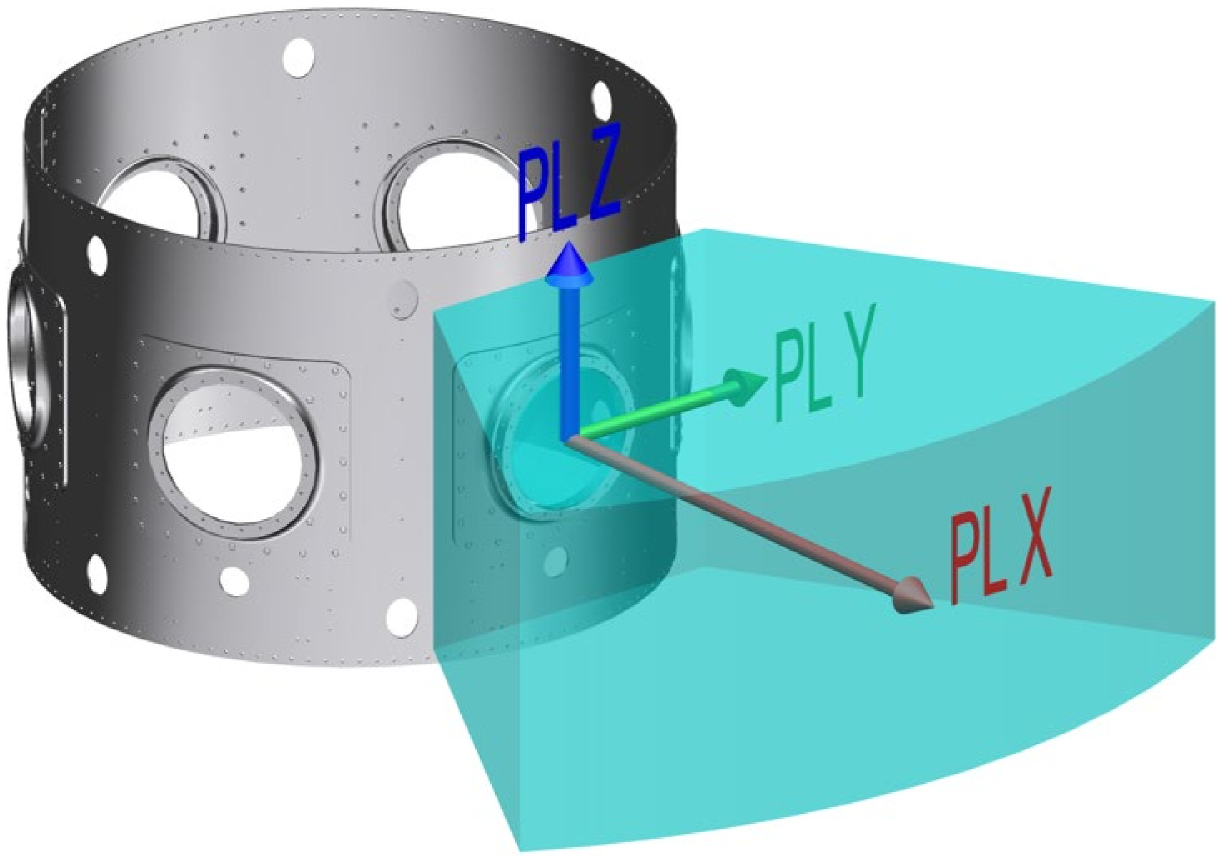

Figure 4-9: Dispenser Ring 15" Diameter Mechanical Interface Volume

4.1.5.2 DISPENSER RING 24" MECHANICAL INTERFACE

The dispenser ring (side-mounted) 24" diameter mechanical interface allowable volume is shown in Figure 4-10 with a base of 48" (Z_{PL}) by ~59" (Y_{PL}) and a 90-degree cone extending ~56" in the X_{PL} direction. In addition, there is an allowable 7" intrusion through the Mechanical Interface Ring. Detailed dimensions can be found in Figure A-6 in Appendix A. Each 24" variant of the dispenser ring can accommodate four Rideshare Payloads.

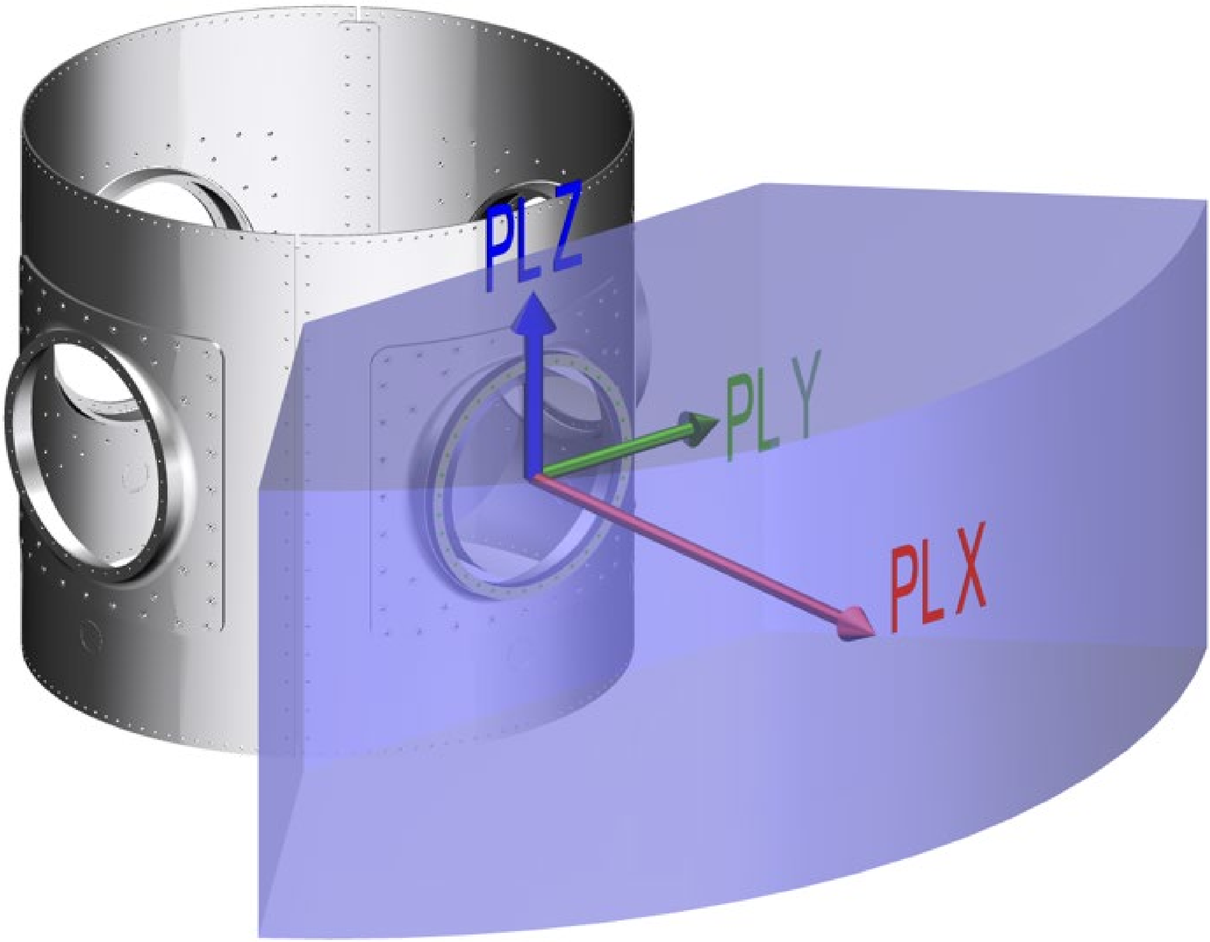

Figure 4-10: Dispenser Ring 24" Diameter Mechanical Interface Volume

4.1.5.3 STARLINK ADAPTER 15" MECHANICAL INTERFACE

The Starlink adapter (forward-mounted) 15" diameter mechanical interface allowable volume is shown in Figure 4-11 with dimensions of 28" (Z_{PL}) by 28" (Y_{PL}) by 40" (X_{PL}). In addition, there is an allowable 1.5" intrusion through the Mechanical Interface Ring. Detailed dimensions can be found in Figure A-7 in Appendix A. Each Starlink adapter plate can accommodate either two 15" diameter Rideshare Payloads or one 24" diameter Rideshare Payload as described in Section 4.1.5.4.

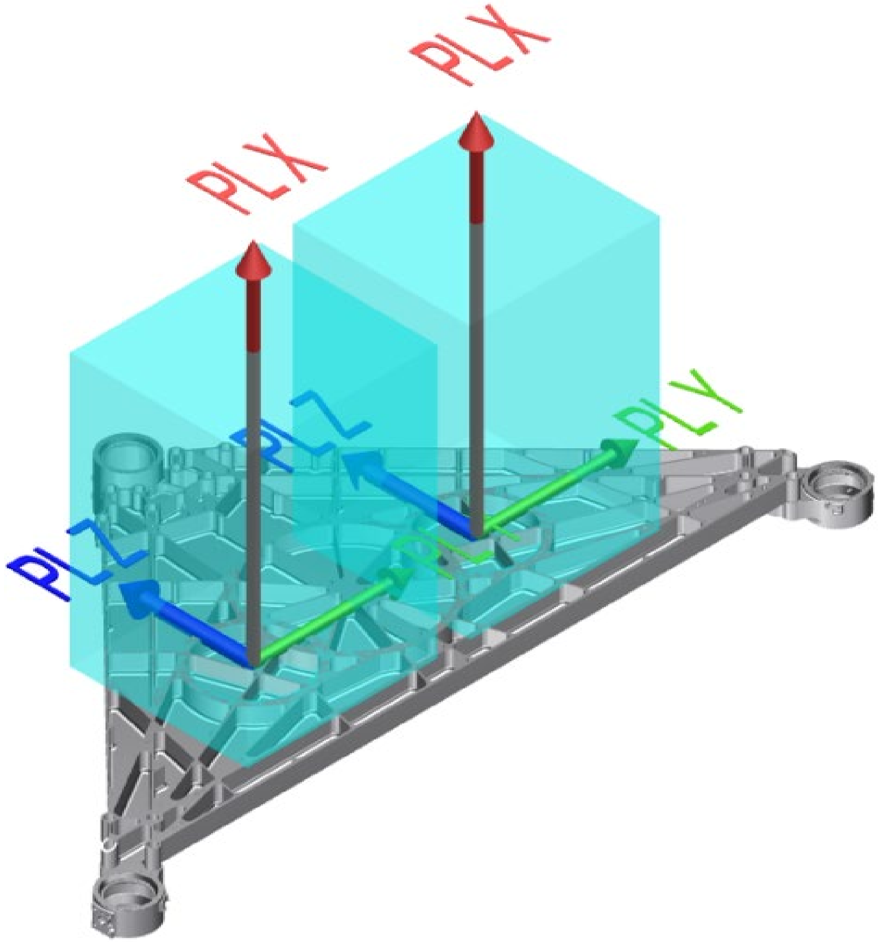

Figure 4-11: Starlink Adapter 15" Diameter Mechanical Interface Volume

4.1.5.4 STARLINK ADAPTER 24" MECHANICAL INTERFACE

The Starlink adapter (forward-mounted) 24" diameter mechanical interface allowable volume is shown in Figure 4-12 with dimensions of 42" (Z_{PL}) by 48" (Y_{PL}) by 60" (X_{PL}). In addition, there is an allowable 1.5" intrusion through the Mechanical Interface Ring. Detailed dimensions can be found in Figure A-8 in Appendix A. Each Starlink adapter plate can accommodate either one 24" diameter Rideshare Payload or two 15" diameter Rideshare Payloads as described in Section 4.1.5.3.

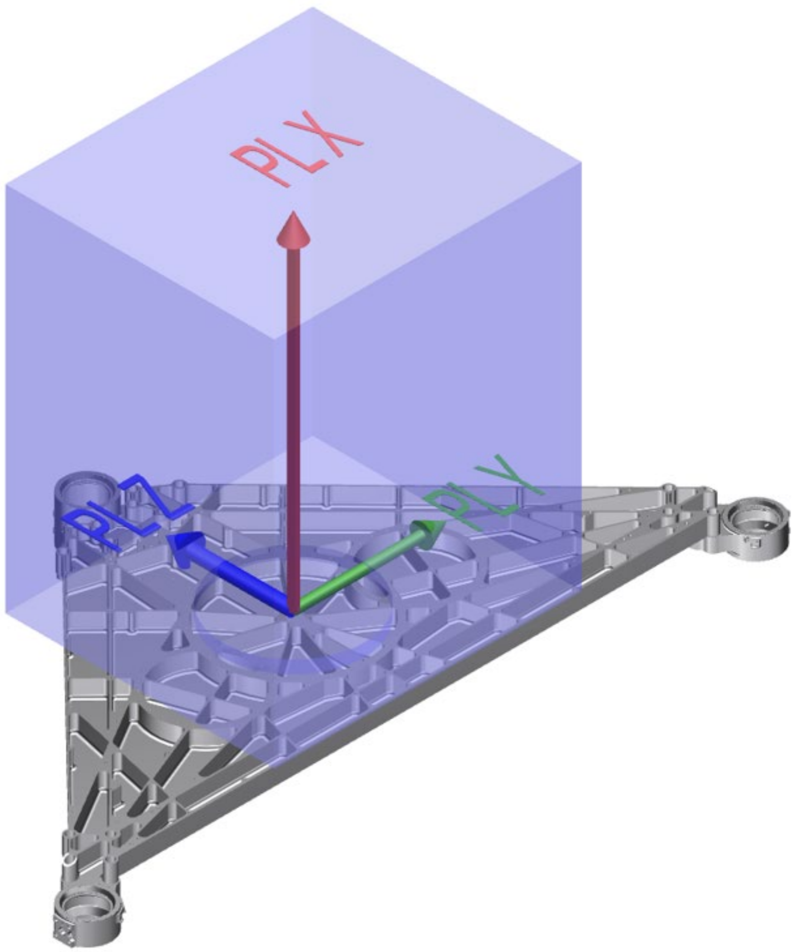

Figure 4-12: Starlink Adapter 24" Diameter Mechanical Interface Volume

4.2 ELECTRICAL INTERFACE

The Launch Vehicle provides electrical connectivity between the Payload and Customer-provided EGSE prior to launch, as well as in-flight separation device initiation and separation monitoring. Besides the in-flight separation device initiation, the Launch Vehicle does not provide either Payload command or interleaved telemetry access as a standard service.

As a standard service, the Launch Vehicle provides a Standard Offering Bulkhead which consists of two separation signal connectors and one umbilical connector as depicted in Figure 4-13 mounted near the Payload mechanical interface. The Starlink rideshare configuration supplies four sets of the connectors shown in Figure 4-13; two sets per 15" diameter mechanical interface or four sets for a single 24" diameter mechanical interface. Mission-specific design documentation is provided to the Customer to define this interface.

Table 4-1: Standard Offering Bulkhead Breakdown per Rideshare Configuration

Configuration	Bulkheads	Total Redundant Deployment Channels	Total Breakwire Channels	Total Umbilical Channels
15" Dispenser Ring	1	1	1	6
24" Dispenser Ring	1	1	1	6
15" Starlink Dispenser	2	2	2	12
24" Starlink Dispenser	4	4	4	24

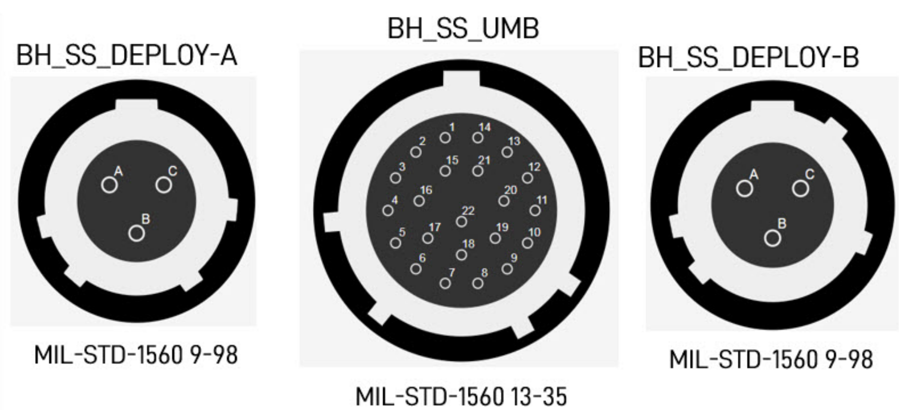

Figure 4-13: Rideshare Payload Electrical Bulkhead Connectors (Launch Vehicle Side)

Each Standard Offering Bulkhead is provided with the channel allocations summarized in Table 4-2. Detailed electrical characteristics and connector pinouts will be captured in the Payload ICD.

Table 4-2: Standard Offering Bulkhead Channels

Channel type	Number of channels (twisted pairs)	Maximum One-Way Resistance (Ω)	Controlled Characteristic Impedance
Umbilical: Battery Charge	2	5	n/a
Umbilical: Battery Sense	2	13.5	n/a
Umbilical: Communication	2	18	100 Ω
Deployment	2 (1 redundant)	n/a	n/a
Breakwire (PL-side loopback)	1	n/a	n/a

The "channel type" represents the expected usage of the channel, but is not a requirement. The Customer can use the umbilical signals as needed for the mission, with the following restrictions:

- The electrical properties of the signal must be de-rated to the advertised capabilities of the cable.
- No AC signals shall be transmitted.

As determined per mission, any Customer-provided harnessing between the separation device and the Standard Offering Bulkhead is expected to be designed and built using the Wire Harness Build Guides delivered to the Customer as part of deliverables described in Appendix G. For each Standard Offering Bulkhead, SpaceX will supply the three Payload side electrical connectors and required accessories that mate with the Launch Vehicle side connectors. The lengths of Customer-built flight harnesses will be determined by the relative position of the Standard Offering Bulkhead(s) and the Payload separation system(s), and are expected to be less than 5 feet, details will be captured as part of the Payload ICD.

4.2.1 CONNECTIVITY DURING PAYLOAD PROCESSING

SpaceX accommodates electrical connectivity between Customer EGSE and the Payload during most processing and integration activities. Table 4-3 summarizes the availability of interfaces during standard processing and integration activities. Customer may connect directly between their EGSE and their Payload during Payload processing operations. Electrical interfaces will not be available during SpaceX adapter mate, encapsulation, Launch Vehicle integration and rollout operations. However, between these steps the Customer will be able to interface with its Payload. Payload batteries must be switched off during Launch. An exception may be made for a battery on standby mode with closed circuit architecture only if electromagnetic test results are provided verifying spurious emissions are within the requirements identified in Section 3.3.6.3; analysis results are insufficient in this case.

Table 4-3: Payload Electrical Interface Connectivity

Phase	Interface Connection
In PPF (Payload processing)	Customer cables directly to Payload
In PPF (adapter mate and encapsulation)	None – no access during mate until after encapsulation
In PPF (encapsulated)	Customer cables to PPF junction box or equivalent interface
Transport to hangar	None – mobile
In hangar (pre-integration)	Customer cables to hangar junction box or equivalent interface
In hangar (LV integration)	None – no access during integration until electrically mated to LV
In hangar (on TE)	Customer cables to hangar junction box or equivalent interface
Rollout	None – mobile
On pad (horizontal and vertical)	None – (available as an optional service – see Appendix I)
Flight	None – separation initiation and indication only

SpaceX will supply the Payload EGSE side electrical connector and any required accessories that mate with the junction box, or equivalent interface, shown in Figure 4-14 to the Customer in order to build the jumper harness between the Payload EGSE and the junction box.

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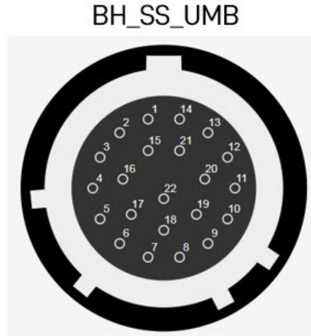

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Figure 4-14: Rideshare Payload EGSE Bulkhead Connector (SpaceX Junction Box Side)

Payload EGSE is connected to a SpaceX-provided junction box or equivalent interface. The Customer is expected to design and build 6.1-m (20-ft) harnesses to connect the Payload EGSE to the junction box found in the EGSE room as shown in Figure 4-15.

The junction box is connected to the Launch Vehicle TE via a ground harness. A harness then runs along the length of the TE and connects to the second-stage T+0 quick-disconnect. The flight side of the second-stage quick-disconnect mates to up to four dedicated Payload electrical harnesses that are provided by SpaceX as part of the second stage, which can support multi-Payload Rideshare configurations. The Payload harnesses are routed along the exterior of the second-stage propellant tanks, underneath raceway covers that provide protection during ground and flight operations. At the top of the second-stage the harnesses are routed through the PAF and to the Standard Offering Bulkhead(s).

The total cable lengths between the Payload racks/EGSE and the SpaceX PAF pass through bulkhead are listed in Table 4-4 and shown in Figure 4-15.

Table 4-4: Maximum Expected Cable Lengths between Payload EGSE and Payload Electrical Bulkhead

Launch Site	PPF	Hangar
VAFB (SLC-4)	37 m (120 ft.)	207 m (679 ft.)
CCAFS (SLC-40)	24.5 m (80 ft.)	196.5 m (644 ft.)
KSC (LC-39A)	24.5 m (80 ft.)	180 m (589 ft.)

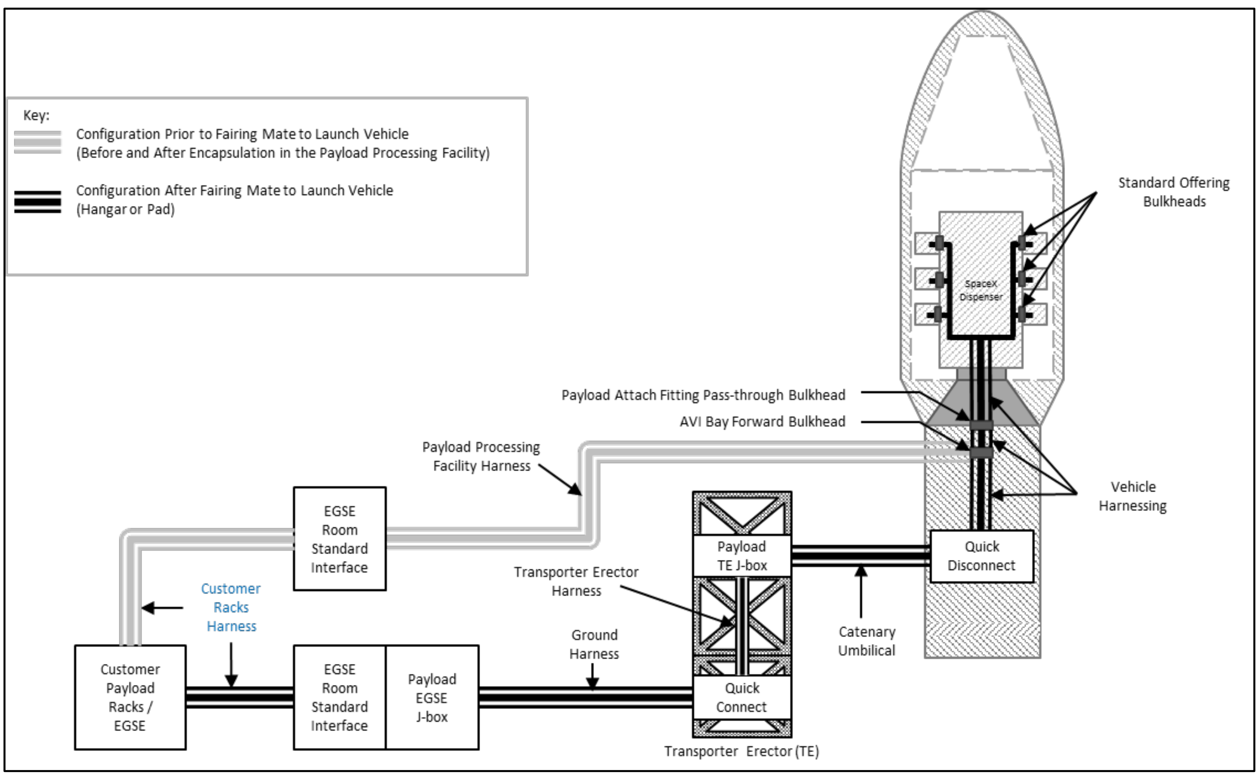

Figure 4-15: Ground Side Electrical Interfaces

4.2.2 LAUNCH VEHICLE-TO-PAYLOAD COMMAND INTERFACE

Separation device commands are used to initiate Payload separation from the second stage. The Launch Vehicle will provide one redundant separation device command to each mechanical interface location. Payloads with multiple satellites installed on a single Mechanical Interface Ring will be required to use a battery powered separation sequencer and SpaceX will approve the final separation timing sequence. The Launch Vehicle does not provide power to the Payload during Launch operations.

The Launch Vehicle will detect the Payload separation events through a breakwire circuit, and a separation indication signal will be included in Launch Vehicle telemetry. SpaceX requires that at least one circuit on the electrical connector be looped back on the Payload side for breakwire indication of Payload separation within Launch Vehicle telemetry. Separation switches or other methods of indicating separation status may be used as a substitute for breakwire loopbacks at SpaceX's sole discretion.

At the Customer's request, SpaceX can provide information on previously flown separation devices in order to help the Customer choose a separation device for their mission.

4.2.3 TIMING SERVICES

SpaceX can supply inter-range instrumentation group IRIG-B000 or IRIG-B120 time from its GPS clocks to Customer EGSE at the PPF.

4.3 INTERFACE COMPATIBILITY VERIFICATION REQUIREMENTS

SpaceX requires that Customer verify the compatibility of their systems with the Launch Vehicle mechanical and electrical interfaces before shipment to the Launch Site. SpaceX, in its sole discretion, may provide access to the Launch Vehicle Mechanical Interface Ring to support a Payload-to-Launch Vehicle mechanical fit check after Payload arrival at the Launch Site but before flight mating. The fit check will confirm the mechanical compatibility of the Mechanical Interface Ring and Customer Payload interface and, optionally, the mechanical alignment of the umbilical connectors, as documented in the Payload ICD.

5 LAUNCH SITE FACILITIES

SpaceX operates a Launch Site at Space Launch Complex 40 (SLC-40) at Cape Canaveral Air Force Station (CCAFS), Florida, Launch Complex 39A (LC-39A) at John F. Kennedy Space Center (KSC), located on Merritt Island off the central Florida coast, and Space Launch Complex 4 East (SLC-4E) at Vandenberg Air Force Base (VAFB), California. Details about these Launch Sites can be found in the SpaceX Falcon User's Guide, latest revision, available on www.spacex.com/vehicles/falcon-9/. SpaceX will provide the Launch Site facilities, equipment, documentation, and procedures to receive Customer's hardware, validate interfaces to Customer's hardware, integrate the Payload with the Launch Vehicle, and perform a Launch of the Payload.

5.1 FACILITY ACCESS AND WORKING HOURS

SpaceX supports Customer personnel access to Launch Site facilities for two eight-hour working shifts per day, during those portions of the Launch Campaign when Customer's activities require use of a given facility. SpaceX additionally supports 24/7 access to Launch Site facilities on an as-needed basis for Customer's scheduled activities throughout the campaign, provided such access is coordinated in advance and mutually agreed with SpaceX. SpaceX supports 24/7 access (24 hours per day, 7 days per week) to Launch Site facilities for responding to emergency or off-nominal situations related to flight hardware.

During the Launch Campaign, SpaceX may provide short-term, controlled facility access to SpaceX personnel, SpaceX's contractors, or other third parties (e.g., other customers, potential customers, VIPs, SpaceX-hosted tours). SpaceX is not required to provide Customer advance notice for short-term, controlled access to areas free of Payload or Customer's hardware. SpaceX will provide prior notice and request approval for physical or visual access to areas with Payload or Customer's hardware. At all times, SpaceX will follow Customer proprietary information and security requirements.

5.2 CUSTOMER OFFICES

SpaceX provides an office area at the Launch Site during Payload processing for up to five (5) Customer and Customer's Related Third Party personnel. The office areas may not be located at the PPF and may be shared with Co-Payload Customer(s). Office accommodations include 100-Mbps-class Internet connection, which may be common with other Customer Internet connections, air conditioning, and standard office equipment such as desks chairs and phones.

5.3 SPACEX PAYLOAD PROCESSING FACILITY (PPF)

SpaceX provides a PPF at the Launch Site for the Customer to perform Payload pre-Launch processing activities. Payload and Co-Payload(s) may be co-located in the processing area. The processing area will be defined in a mission-specific Launch Campaign Plan based on Payload and Co-Payload(s) space requirements. The Payload processing area will:

a. Operate at ISO 14644-1 Class 8 (Class 100,000) cleanliness.
b. Operate at 70°F ± 5°F air temperature (21°C ± 3°C).
c. Operate at 45% ± 15% relative humidity.
d. Be equipped with blast shielding.
e. Include 30-ton and 10-ton capacity cranes with 100 ft. (30 m) hook height.
f. Provide minimum floor dimensions of 15 ft. by 10 ft. for Payload processing activities.

The PPF includes an area for Payload EGSE, which is located adjacent to the Payload processing area and provide a 100-Mbps-class Internet connection, which may be common with other Customer Internet connections.

5.4 LAUNCH COMPLEX

SpaceX provides a Launch Complex including the launch pad, and related Launch Vehicle GSE. SpaceX provides conditioned air into the fairing including environmental monitoring of the encapsulated Payload when at the launch pad. In the event of a Launch Site power outage, conditioned air will be resumed on backup power systems within 10 minutes.

5.5 LAUNCH COUNTDOWN MONITORING

SpaceX may provide Customer personnel (determined on an as-needed basis) a space at the Launch Site for launch countdown monitoring. Space will be shared between Payload and Co-Payload Customer(s), as documented in the mission-specific Launch Campaign Plan.

6 MISSION INTEGRATION AND SERVICES

6.1 CONTRACTING

Rideshare Launch Services are available via direct contract with SpaceX and through certain managed procurement services. To begin your direct contract relationship with SpaceX, please visit www.spacex.com/rideshare.

6.2 US EXPORT AND IMPORT CONTROL LAWS

Provision of all items, information, and services identified in the Agreement by SpaceX to any foreign person (including Customer and/or Customer's Related Third Parties, if applicable) is subject to US export control laws, including the ITAR, administered by the US Department of State, and EAR, administered by the US Department of Commerce. Customer must comply with US export and import control laws, including clearance from US Customs and Border Protection, with respect to the Payload and any Customer provided hardware, including GSE and propellant (if any).

If SpaceX reasonably determines that obtaining a License by either Party is not possible or highly unlikely within a reasonable amount of time, despite commercially reasonable efforts by both parties to do so, SpaceX reserves the right to re-book Customer, with applicable rebooking fees, or terminate the Agreement and return all amounts paid to Customer, without interest, with no further liability.

6.3 MISSION MANAGEMENT

To streamline communication and ensure customer satisfaction, SpaceX provides each Launch Services Customer with a single technical point of contact from contract award through launch (Figure 6-1). Your mission manager will be responsible for coordinating Mission integration analysis and documentation deliverables, planning integration meetings and reports, conducting Mission-unique analyses and coordinating all integration and test activities associated with the Mission. The mission manager also coordinates all aspects of Launch Vehicle production, range and range safety integration, and all Mission-required licensing leading up to the Launch Campaign. The mission manager works closely with the Customer, SpaceX technical execution staff and all associated licensing agencies in order to achieve a successful Mission.

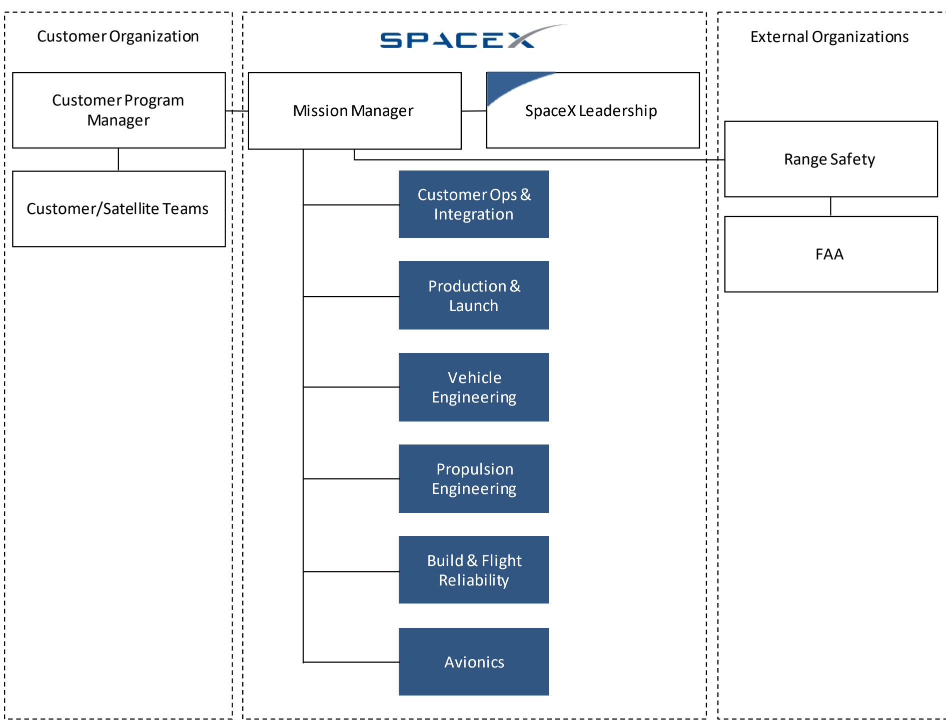

Figure 6-1: Mission Management Organization

6.4 PROGRAM DOCUMENTATION

6.4.1 INTERFACE CONTROL DOCUMENT (ICD)

SpaceX creates and maintains the Payload ICD in conjunction with Customer inputs. The Payload ICD will be negotiated in good faith between the Parties and at a minimum define physical interfaces (mechanical and electrical), functional requirements (orbit, attitude, etc.), Payload MPEs, and Launch operations requirements. Following signature by SpaceX and Customer, the Payload ICD will take precedence (in the event of a conflict) over the Statement of Work (SOW). Prior to signature, the Payload ICD is maintained in draft. SpaceX will deliver the Payload ICD for signature following the completion of Mission integration analyses. Once delivered for signature, the Parties will work in good faith to promptly sign the Payload ICD.

6.4.2 LAUNCH CAMPAIGN PLAN

SpaceX provides a Launch Campaign Plan and schedule of Launch Site operations, including required delivery dates for Launch Range-related documentation. SpaceX will coordinate with the Customer to integrate Launch Vehicle and Payload timelines into this plan.

6.4.3 PROGRAM STATUS, MEETINGS, WORKING GROUPS AND REVIEWS

SpaceX will provide program status and conduct meetings, working groups and reviews as described in the following subsections. SpaceX will provide advance copies of deliverables, as noted; otherwise, deliverables will be provided at the time of the corresponding event.

6.4.3.1 INTEGRATION WORKING GROUPS

SpaceX will organize integration working group meetings on an as-needed basis to address specific issues or operations related to integration of the Payload with the Launch Vehicle. The meeting schedules and locations will be mutually agreed between the Parties. Topics may include the following:

a. Coordinating Mission integration analyses and reviewing results.
b. Confirming physical and functional interfaces.
c. Preparing, reviewing, and approving the Payload ICD.
d. Preparing Payload-to-Launch Vehicle test activities.
e. Planning the logistics and shipment of hardware to the Launch Site.
f. Planning Mission-specific ground and flight operations, including associated GSE.
g. Scheduling PPF activities including hazardous operations between Payload and Co-Payload(s)

6.4.3.2 PROGRAM REVIEWS AND MILESTONES

SpaceX will hold program reviews and achieve the program milestones summarized below. Program reviews and milestones include:

a. Mission Integration Kickoff.
b. Completion of Mission Integration Analyses.
c. Launch Campaign Readiness Review.

6.5 CUSTOMER RESPONSIBILITIES

Customer responsibilities include the following items. Timely completion is necessary to ensure that SpaceX can fulfill its responsibilities and obligations described in Section 6.6. The Parties understand that any material failure by Customer to meet its responsibilities, including any non-compliance with the Payload ICD, may result in a Customer delay requiring rebooking with applicable fees.

6.5.1 TRANSPORTATION

- Customer is responsible for delivering the Payload and associated GSE via road transport to the PPF or other Launch Site facility designated by SpaceX. Customer remains responsible for environmental control of the

Payload during Payload delivery, until the Payload is removed from its shipping container, including generators and fuel to maintain environmental control.

- Customer delivers the Payload and GSE to the Launch Site no more than six weeks prior to the Launch Date unless requested by SpaceX. Timing of delivery will be coordinated by SpaceX based on Payload and Co-Payload(s) processing schedule.
- Customer arranges and executes the shipment of the Payload shipping container and all Customer-furnished GSE from the Launch Site no later than three days after Launch.
- Customer is responsible for all shipping and logistics of hazardous items from the port of entry to the Launch Site, including the required labeling for storage at the Launch Site.
- Customer is responsible for obtaining any required permits, Licenses, or clearances, including from U.S. Customs and Border Protection for Customer's and Customer's Related Third Parties' hardware and consumables.

6.5.2 HARDWARE, PROCESSING AND INTEGRATION

- Customer provides the Payload and all Payload-unique GSE required for Customer's Launch readiness activities at the Launch Site, interfacing to SpaceX hardware at the Launch Site (as defined in the Payload ICD), and ensure that all Payload and Payload-unique GSE meet the appropriate safety requirements, reference Section 8.1.
- Customer will coordinate activities with SpaceX to create an integrated schedule and procedures where necessary.
- Beginning upon Payload arrival at the Launch Site and throughout the Launch Campaign, Customer provides to SpaceX once per working day, an updated Payload processing schedule. The schedule should include a three day look-ahead summarizing all items requiring SpaceX support, such as: opening processing area doors, SpaceX GSE usage (cranes, forklifts, man lifts, etc.), and any other items requiring SpaceX support. Note also, Payload hazardous operations require 72 hours' advance notice, with precise activity timing, from SpaceX to the Launch Range safety authorities.
- Upon request, Customer will provide SpaceX with access to the flight-mating interface for a mating interface to Mechanical Interface Ring fit check after Payload arrival at the Launch Site but before flight mating.
- Customer is responsible for providing all personal protective equipment, such as fall protection harnesses, for Customer and Customer's Related Third Parties at the Launch Site. Customer and Customer's Related Third Parties may not borrow personal protective equipment from SpaceX personnel.
- Customer is responsible for cleaning all Customer-provided equipment and hardware to the appropriate SpaceX-designated contamination-control levels prior to entering SpaceX's cleanliness-controlled facilities at the Launch Site (e.g. the PPF). Standard cleaning products (e.g. isopropyl alcohol and cleanroom wipes) are provided by SpaceX; however, SpaceX personnel will not clean Customer hardware.
- The Payload will not have RF transmissions once mated to Launch Vehicle hardware until after Payload separation as defined Section 0. Any Payload RF checkouts required at the PPF must be contained within the processing area referenced in Section 5.3. Timeline for any approved checkouts will be documented in the Launch Campaign Plan.
- The Payload will have access to the electrical harnesses referenced in Section 4.2 for Payload health checks and battery charging up until Launch Vehicle rollout from the integration hangar to the Launch pad. Additional access to Payload telemetry and battery charging can be procured as an optional service (see Appendix I).

6.5.3 HAZARDOUS PROCEDURES

Fueling of Rideshare Payloads at the Launch Site is available as an optional service (see Appendix I), but not part of the standard offering.

- Customer will provide any pressurant and other consumables required by the Payload, including transportation of such consumables to and from the Launch Site. Delivery of all Payload consumables must be coordinated in advance with SpaceX.
- Customer will provide advance copies of all hazardous operation procedures, in addition to a Payload GOP (Ground Operations Plan) which references each hazardous procedure (reference Appendix G). Hazardous procedures and the GOP are reviewed and approved by the Launch Range safety authority. Customer will also provide copies of any non-hazardous procedures requested by the Launch Range safety authority.
- Customer will arrange for and implement the disposal of hazardous waste generated during Payload processing activities in accordance with Launch Range and facility regulations.
- Customer will provide the necessary decontamination equipment and perform all required decontamination activities for Payload GSE that is contaminated by hazardous substances during Payload processing activities in accordance with Launch Range and facility regulations.

6.5.4 ENTRY AND EXIT VISAS

Customer is responsible for obtaining any visas required for Customer's personnel; including Customer's Related Third Parties and guests. SpaceX can provide letters of invitation for Customer's Launch Campaign personnel to support the issuance of U.S. entry visas by the U.S. Department of State

6.5.5 ANOMALY, MISHAP, ACCIDENT OR OTHER EVENT

In the event of an anomaly, mishap, accident or other event resulting in property damage, bodily injury or other loss, Customer will cooperate with SpaceX, any insurers, and federal, state and local government agencies, in their respective investigations of the event, including the completion of witness statements, if applicable. Such cooperation will include providing all data arising out of or related to the Payload, any ground support, and any activities relating to the performance of the Agreement, reasonably requested by SpaceX, the insurers, or federal, state and local agencies. Notwithstanding Customer's obligation to cooperate, SpaceX may use reasonable means to independently access such information. Customer and Customer's customers may not make any public comment, announcement, or other disclosure regarding such event without SpaceX's review and approval.

6.5.6 PAYLOAD LICENSING AND REGISTRATION

Customer will flow down its responsibilities relating to Payload licensing and registration under the Agreement (including registration pursuant to the Convention on Registration of Objects Launched into Outer Space) to each of its customers, in writing. Evidence of proper flow-down will be provided to SpaceX upon request. Customer will provide a letter in the form of Appendix F, certifying that Customer has obtained all required Licenses and that all Payload information provided to SpaceX and/or any licensing agencies is complete and accurate.

6.6 SPACEX RESPONSIBILITIES

SpaceX responsibilities include the following items. The Parties understand that any material failure by SpaceX to meet its responsibilities may result in changes in the scheduling of the Launch Period or Launch Date; such changes are not subject to any Customer rebooking fees.

6.6.1 LAUNCH SCHEDULING

SpaceX will advise the Customer approximately sixty days prior to the start of the Launch Period, of the Launch Date. The above-referenced dates will be determined by SpaceX in its sole discretion.

6.6.2 TRANSPORTATION SERVICES

- SpaceX will provide transportation of the Payload and associated GSE between facilities at the Launch Site. This includes transportation of the Payload from the PPF to the Launch Complex and transportation of hazardous fluids and gasses between facilities at the Launch Site.
- SpaceX will provide Launch Range coordination for Payload and associated GSE transportation activities when at the Launch Site.

- To the extent required by the Launch Range, SpaceX will arrange safety and security escorts for Payload and GSE transportation events at the Launch Site.
- SpaceX will provide transportation for Customer's non-U.S. personnel between a designated off-site parking area and SpaceX Launch Site facilities, and between SpaceX facilities, on a reasonable schedule. U.S. government regulations require that non-U.S. personnel and U.S. personnel representing non-U.S. entities must be escorted while on a U.S. government Launch Site.

6.6.3 PAYLOAD INTEGRATION AND ASSOCIATED HARDWARE

- SpaceX will lead the operations required to physically integrate the Payload with the Launch Vehicle, including any operations involving integrated Payload and Launch Vehicle hardware.
- SpaceX will provide all non-Payload-unique encapsulation equipment, the GSE required to handle the encapsulated Payload, and the GSE required to transport the encapsulated Payload to the Launch Complex.
- SpaceX will provide the equipment to integrate the encapsulated Payload with the Launch Vehicle at the Launch Complex.

6.6.4 PHOTOGRAPHIC SERVICES

At SpaceX's sole discretion, SpaceX may provide still photography and/or videography services during selected Payload processing, testing and integration operations. This service does not include delivery or broadcast of photography or videography in real-time or near real-time.

All media intended for release is subject to Launch Range security procedures, U.S. export control laws, and where applicable, the prior written approval of the U.S. Government. Media that includes images of SpaceX hardware or facilities is also subject to SpaceX's prior written approval for release.

6.6.5 SECURITY

SpaceX provides security via a combination of locked facilities (security card access or cipher locks), closed circuit video monitoring and/or personnel present 24 hours/day at the relevant Launch Site facilities when Customer flight hardware is present. During any hazardous operations for which the Launch Range safety authority requires non-essential personnel to evacuate, video monitoring will be the sole method of surveillance available. Customer will not be granted access to SpaceX's video footage.

6.6.6 LAUNCH CAMPAIGN

SpaceX will prepare for and perform a Launch of the Payload. Starting upon Payload arrival at the Launch Site and throughout the Launch Campaign, the SpaceX mission manager will provide to the Customer, at least once per working day, an updated Launch Campaign schedule (including key milestones and joint operations), relevant Launch Range safety status and information, and Launch Vehicle integration status.

SpaceX may conduct one or more Launch Vehicle wet dress rehearsals (inclusive of loading the Launch Vehicle with propellant) and static fire tests (inclusive of first-stage engine ignition) at the launch pad prior to Launch.

6.6.7 FACILITY SUPPORT AND OPERATIONS

SpaceX will integrate the scheduling of Payload processing activities with Launch Vehicle processing activities. SpaceX will maintain and communicate the integrated schedules and procedures. In addition, SpaceX will act as the primary point of contact between the Launch Range and the Customer and coordinate all Launch Range support, including the following

a. Launch Range security and badge control
b. Launch Range scheduling
c. Launch Range system safety
d. Meteorology
e. Communications and timing

f. Fire protection
g. Non-hazardous fluids and gases:
    a. Gaseous helium per MIL-PRF-27407, Grade A (5700 psi max)
    b. Gaseous nitrogen per MIL-PRF-27401, Grade A (4150 psi max)
    c. Compressed Air (120 psi max)
    d. Isopropyl Alcohol (IPA)

SpaceX will maintain PPF management and scheduling responsibilities throughout the Payload processing and encapsulation phase. As facility manager, SpaceX will require some oversight of Payload activities.

SpaceX will provide training for Customer personnel regarding the PPF (cranes, warning lights, etc.) and applicable Launch Range/facility safety and security procedures. Training will be provided in advance of Payload arrival and offloading at the Launch Site.

6.6.8 LICENSING AND REGISTRATION

SpaceX will provide to Customer commercially reasonable support and information to enable Customer to satisfy the requirements of all applicable regulatory/licensing agencies and associated statutes, including Launch Range safety, the US Departments of State and Commerce, the US FAA, the US FCC and the CSLA.

Each Party will be responsible for obtaining all Licenses to carry out its obligations under the Agreement. For example, SpaceX is responsible for licensing RF emissions entering free-space from SpaceX-provided hardware and the Customer is responsible for licensing RF emissions entering free-space from Customer-provided hardware.

If Customer or any of Customer's Related Third Parties takes any action or fails to take an action that SpaceX reasonably determines requires delaying any application for or amending any License for which SpaceX is responsible to obtain, SpaceX reserves the right to re-book Customer, with applicable rebooking fees.

6.6.9 MISSION INTEGRATION ANALYSES

SpaceX will conduct the following analyses in support of the Payload if required. All other environments are verified by Customer using requirements found in Section 3.

6.6.9.1 TRAJECTORY

SpaceX performs a trajectory and performance analysis in order to analyze the following Mission parameters:

a. The nominal flight timeline, profile (plots of altitude and acceleration. vs. time), and ground track
b. The free molecular heating environment at fairing jettison
c. The Earth-Centered-Earth-Fixed (ECEF) Payload separation state vector
d. Payload and Co-Payload(s) deploy timeline
e. Orbit injection accuracy

SpaceX analyzes and implements a single Earth-referenced Launch trajectory, a single Earth-referenced ascent attitude profile, and a single Earth-referenced Payload separation attitude, which will be used for all dates and times throughout the Launch Period. SpaceX does not implement multiple trajectories for various dates/times within the Launch Period, and does not provide sun-referenced or inertially-referenced attitudes during ascent or for Payload separation. Results will be provided by SpaceX.

6.6.9.2 COLLISION AVOIDANCE

SpaceX performs an analysis to determine the need for a collision avoidance maneuver following separation of Payload and Co-Payload(s). This analysis will characterize the relative separation distance between the second stage and the Payload for one orbit after separation. This analysis will assume that no propulsive activities are executed by the Payload during the period analyzed. SpaceX does not perform additional analyses with respect to collision avoidance of potential debris or other space objects. These results will be provided by SpaceX as part of the trajectory and performance results described in Section 6.6.9.1.

SpaceX coordinates with applicable US regulatory authorities, such as the FAA and the Combined Space Operations Center (CSpOC), to select a Launch Window that results in a sufficiently low risk of collision with another space object during the Mission. In order to facilitate this coordination with the regulatory authorities, SpaceX will utilize the separation velocity imposed on the Payload by the separation system as documented in the Payload ICD and position predicted by the Trajectory analysis. Any Payload propulsive maneuvers or secondary Payload deployments within three (3) hours of Launch must be coordinated with SpaceX for inclusion in CSpOC analysis and will be documented in the Payload ICD.

6.6.9.3 COUPLED LOADS

SpaceX performs a CLA to verify the predicted dynamic flight loads and responses of the Payload are within the MPE described in Section 3.3.1. If any results are found to exceed the MPE described in Section 3.3.1, SpaceX will provide the CLA results to the Customer for further evaluation.

6.6.9.4 FAIRING VENTING

SpaceX performs a fairing venting analysis to verify the predicted internal pressure and pressurization rate of the fairing compartment as a function of time from lift-off to fairing jettison, using inputs from Payload and Co-Payload(s). If the predicted internal pressure or pressurization rate exceed the MPE described in Section 3.3.7, results will be provided to the Customer for further evaluation.

6.6.9.5 PAYLOAD SEPARATION

SpaceX may perform a separation analysis for MicroSat-class Payload Constituents deploying from the Launch Vehicle to verify Customer provided analysis as described in Section 2.4. CubeSat deployments from Containerized deployers are not specifically analyzed; SpaceX instead relies on the separation properties provided by the Customer. These results are used as an input for the collision avoidance analysis. Since Payload mass properties and slosh are outside of SpaceX's control, SpaceX will evaluate requirements compliance via the ideal analysis case. If required, SpaceX will provide a presentation summarizing the results of the analysis and highlighting any issues or concerns for the Payload.

6.6.9.6 PAYLOAD CLEARANCE

SpaceX performs a clearance analysis to validate the dynamic envelope compatibility between the Launch Vehicle and the Payload, and the Co-Payload(s) to the Payload, during all phases of the Mission. Clearance analysis results will be provided to the Customer for any Payload in excess of the allowable Payload volume defined in Appendix A.

7 OPERATIONS

Launch Vehicle operations are described in this section for launches from CCAFS, KSC, and VAFB. SpaceX launch operations are designed for rapid response (targeting less than one hour from vehicle rollout from the hangar to launch). Customers are strongly encouraged to develop launch readiness capabilities and timelines consistent with a rapid prelaunch concept of operations.

7.1 OVERVIEW AND SCHEDULE

The Launch Vehicle system and associated operations have been designed for minimal complexity and minimal time at the pad. Customer Payload processing is performed in the PPF. After completion of standalone Payload operations (over a 7-day period), SpaceX performs the Payload mate to Launch Vehicle hardware followed by fairing encapsulation at the PPF. Payload and Co-Payload arrivals will be scheduled by SpaceX and may be staggered. The encapsulated assembly is then transported to the integration hangar. The Launch Vehicle is processed in the integration hangar at the Launch Complex and then loaded on the TE. The encapsulated assembly is mated to the Launch Vehicle at approximately L-5 days, followed by end-to-end system checkouts. Launch Vehicle systems are designed for rollout and Launch on the same day.

7.2 RIDESHARE PAYLOAD DELIVERY AND TRANSPORTATION

Payload and associated GSE must be delivered to the Launch Site via ground transport. Customer is responsible for arranging transport to the Launch Site, while SpaceX will assist in arranging for Air Force Base access.

7.3 RIDESHARE PAYLOAD PROCESSING

SpaceX provides an ISO Class 8 (Class 100,000) PPF for processing Customer Payload, including equipment unloading, unpacking/packing, final assembly, nonhazardous flight preparations, and checkouts. The PPF is available to Customer for two eight-hour working shifts per day. Layouts as well as standard services and equipment available in the PPF for VAFB and CCAFS can be found in the SpaceX Falcon User's Guide, latest revision, available on www.spacex.com/vehicles/falcon-9/.

The PPF is also designed to accommodate hazardous operations such as hypergolic propellant loading and ordnance installation. Fueling operations are allowed as an optional service (see Appendix I).

7.4 JOINT OPERATIONS AND INTEGRATION

Joint operations begin once Customer has completed the Payload mate to the Mechanical Interface Ring. Payload (with the Mechanical Interface Ring) mate to Launch Vehicle hardware and fairing encapsulation are performed by SpaceX within the PPF. Fairing encapsulation is performed in the vertical orientation. Transportation is performed in the vertical orientation, and environmental control is provided throughout the transportation activity. Once at the Launch Vehicle integration hangar, the encapsulated assembly is rotated to horizontal and mated with the Launch Vehicle already positioned on the TE.

Once the encapsulated assembly is mated to the Launch Vehicle, the hangar facility HVAC system is connected via a fairing air conditioning duct to maintain environmental control inside the fairing. The Payload and Co-Payload(s) are then reconnected to EGSE (if required) and Customer has a final chance to perform electrical checkouts prior to Launch Vehicle rollout and launch.

7.5 LAUNCH OPERATIONS

7.5.1 ORGANIZATION

A breakdown of decision-making roles between SpaceX and the Launch range can be found in SpaceX Falcon User's Guide, latest revision, available on www.spacex.com/vehicles/falcon-9/.

7.5.2 LAUNCH CONTROL

Launch countdown monitoring and access to Payload telemetry throughout the Launch countdown is available as an optional service (see Appendix I). Space within the Launch Control Center would be shared between Payload and Co-Payload Customer(s), as documented in a Launch Campaign Plan.

7.5.3 ROLLOUT AND PAD OPERATIONS

After all Payload and Co-Payload(s) EGSE is disconnected and readiness is verified the integrated Launch Vehicle may be rolled out from the hangar to the pad on the TE. Once the Launch Vehicle is at the pad, the fairing air conditioning system is reconnected, which helps maintain environmental control through liftoff. Electrical connectivity is provided via ground cables (reference Section 4.2.1). The Launch Vehicle will typically be erected only once, although the capability exists to easily return it to a horizontal orientation if necessary.

7.5.4 COUNTDOWN

The Launch Vehicle is designed to support a countdown duration as short as one hour. Early in the countdown, the vehicle performs LOX, RP-1 and pressurant loading, and it executes a series of vehicle and range checkouts. The TE strongback is retracted just prior to launch. Automated software sequencers control all critical Launch Vehicle functions during terminal countdown. Final Launch activities include verifying flight termination system status, transferring to internal power, and activating the transmitters. Engine ignition occurs shortly before liftoff, while the Launch Vehicle is held down at the base via hydraulic clamps. The flight computer evaluates engine ignition and full -power performance during the prelaunch hold-down, and if nominal criteria are satisfied, the hydraulic release system is activated at T-0. A safe shutdown is executed should any off-nominal condition be detected.

7.5.5 RECYCLE AND SCRUB

Launch Vehicle systems and operations have been designed to enable recycle operations when appropriate. Although every recycle event and launch window requirement is unique, the Launch Vehicle offers the general capability to perform multiple recycles within a given launch window, eliminating unnecessary launch delays.

In the event of a launch scrub, the TE and Launch Vehicle will stay vertical. However, for any long-duration Launch postponements, SpaceX will return the Launch Vehicle on the TE to the hangar.

7.6 FLIGHT OPERATIONS

A summary of Launch Vehicle flight operations including Liftoff, Ascent, and Payload Separation can be found in SpaceX Falcon User's Guide, latest revision, available on www.spacex.com/vehicles/falcon-9/. SpaceX will provide a quick-look orbit injection report to the Customer shortly after Payload separation, including a best-estimate Payload separation state vector as described in Appendix E.

8 SAFETY

8.1 SAFETY REQUIREMENTS

Customers are required to meet AFSPCMAN 91-710 Range User's Manual and FAA 14 CFR Part 400 requirements in the design and operation of their flight and ground systems. These requirements encompass mechanical design, electrical design, fluid and pressurant systems, lifting and handling systems, ordnance and RF systems, GSE, and other design and operational features. SpaceX will serve as the safety liaison between the Customer and the range and will provide templates for document compliance.

8.2 HAZARDOUS SYSTEMS AND OPERATIONS

Most ranges consider hazardous systems and operations to include ordnance operations, pressurized systems that operate below a 4-to-1 safety factor, lifting operations, operations or systems that include toxic or hazardous materials, high-power RF systems and laser systems, and a variety of other systems and operations. The details of the system design and its operation will determine whether the system or related operations are considered hazardous. Typically, additional precautions are required for operating systems that are considered hazardous, such as redundant valving between pressurant and propellant. Additional precautions will be determined during the safety approval process with SpaceX and the Launch Range. All hazardous operations require procedures that are approved by both SpaceX and the Launch Range prior to execution. Ordnance operations, in particular, require coordination to provide reduced RF environments, cleared areas, safety support and other requirements.

8.3 WAIVERS

For systems or operations that do not meet safety requirements but are believed to be acceptable for ground operations and launch, a waiver is typically produced for approval by the Launch Range safety authority. Waivers require considerable coordination and are considered a last resort; they should not be considered a standard practice.

APPENDIX A: MECHANICAL INTERFACE (RINGS & VOLUMES)

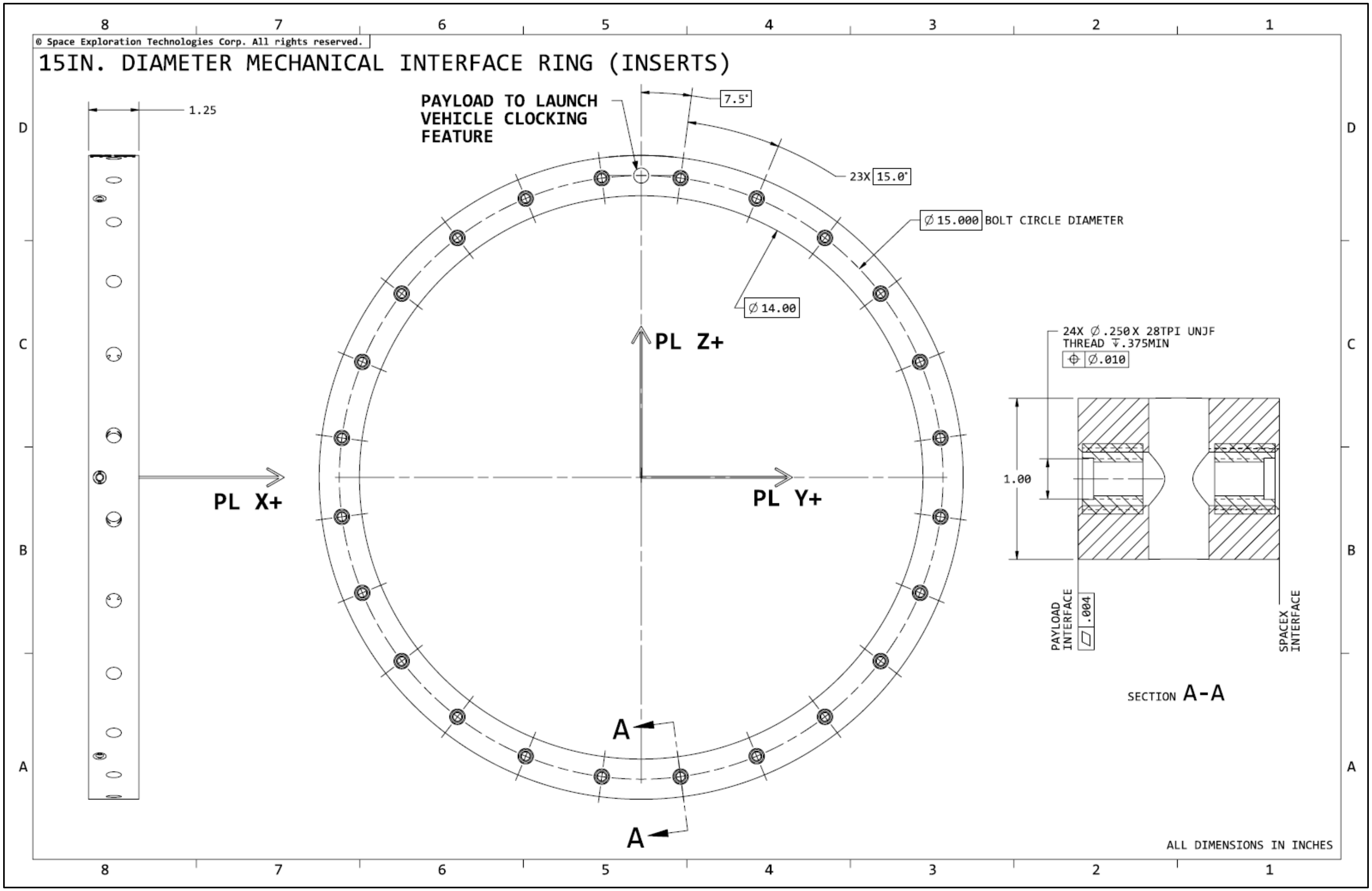

Figure A-1: 15" Diameter Mechanical Interface Ring (Inserts)

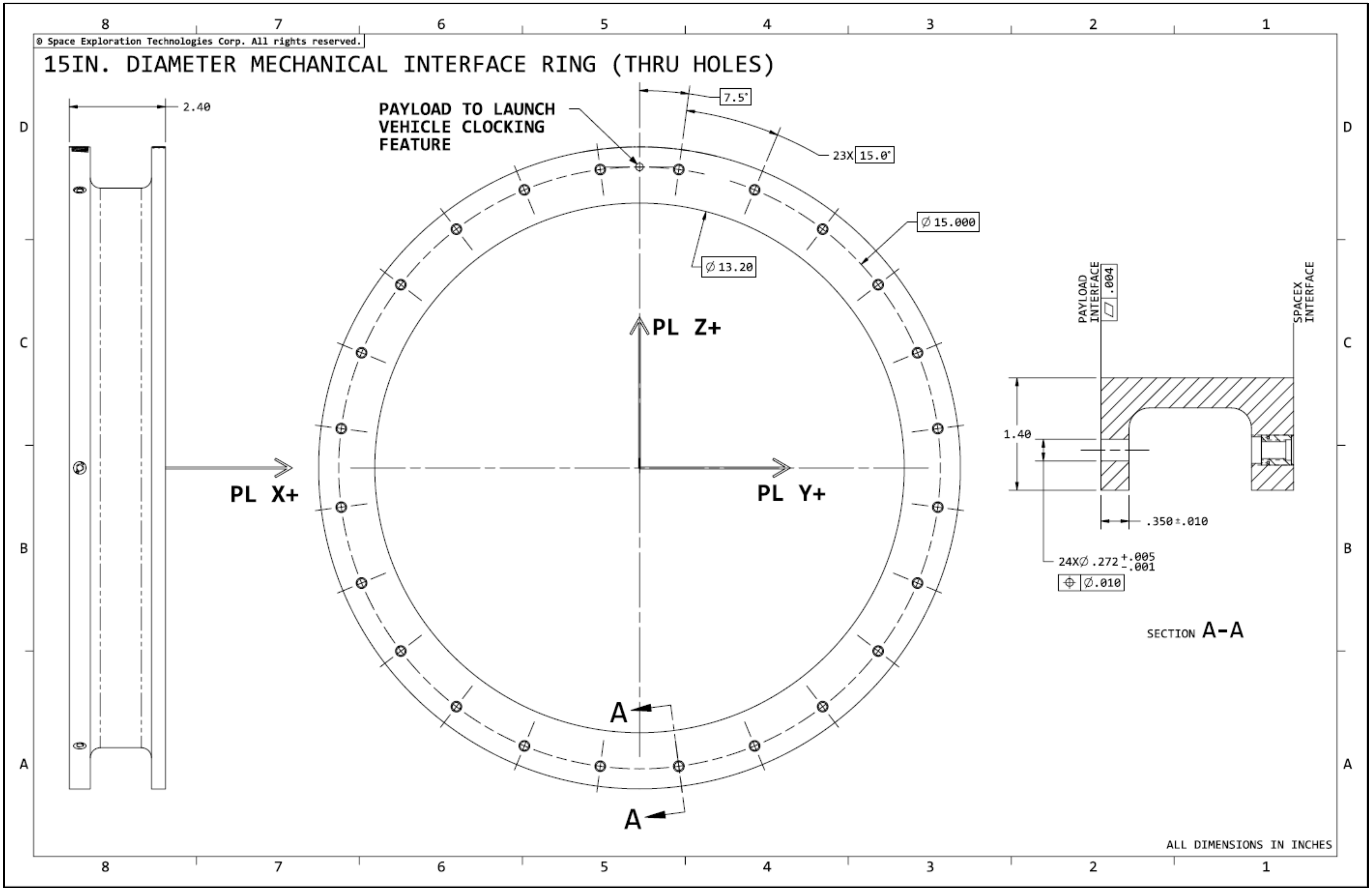

Figure A-2: 15" Diameter Mechanical Interface Ring (Thru-Holes)

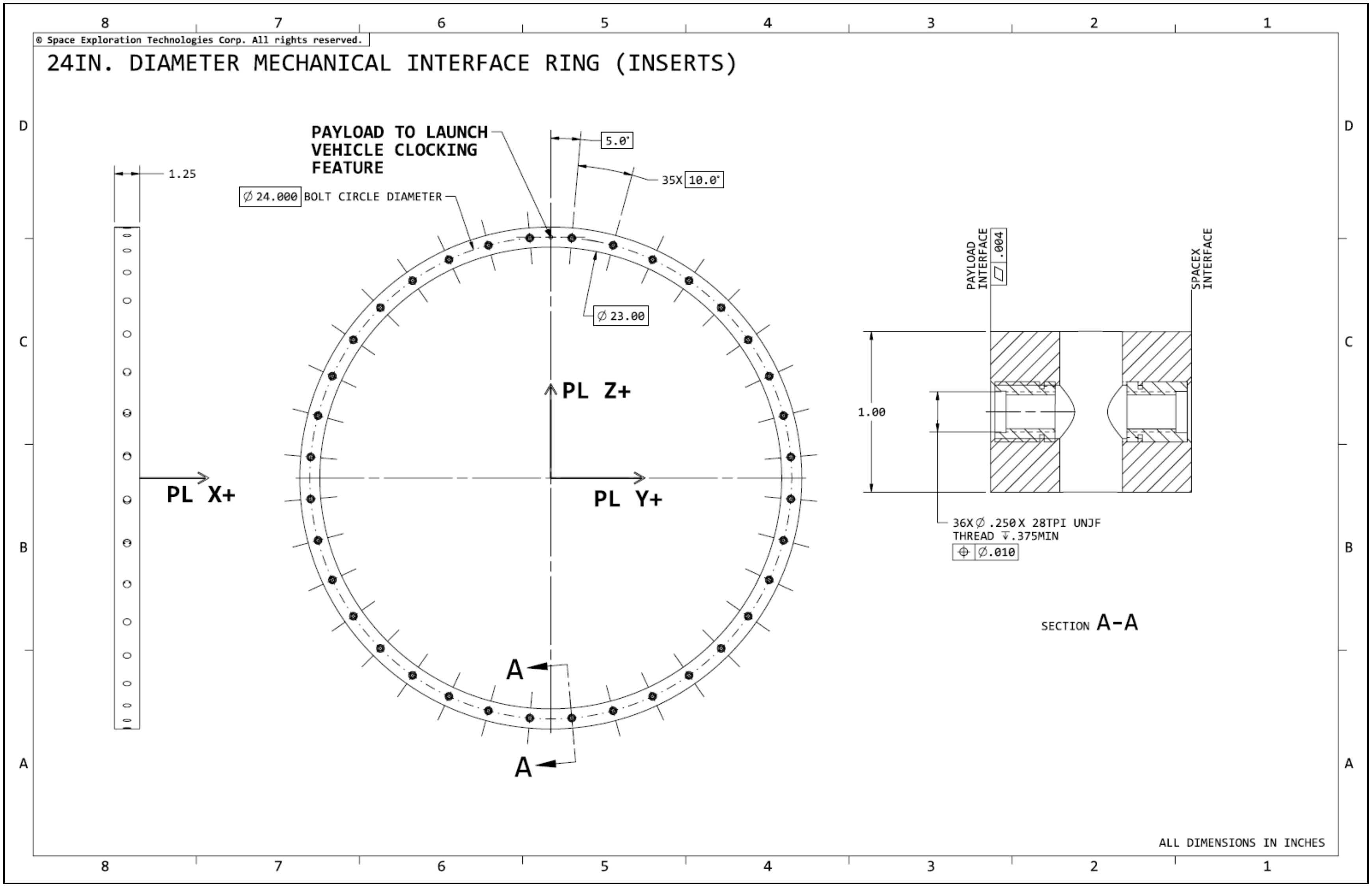

Figure A-3: 24" Diameter Mechanical Interface Ring (Inserts)

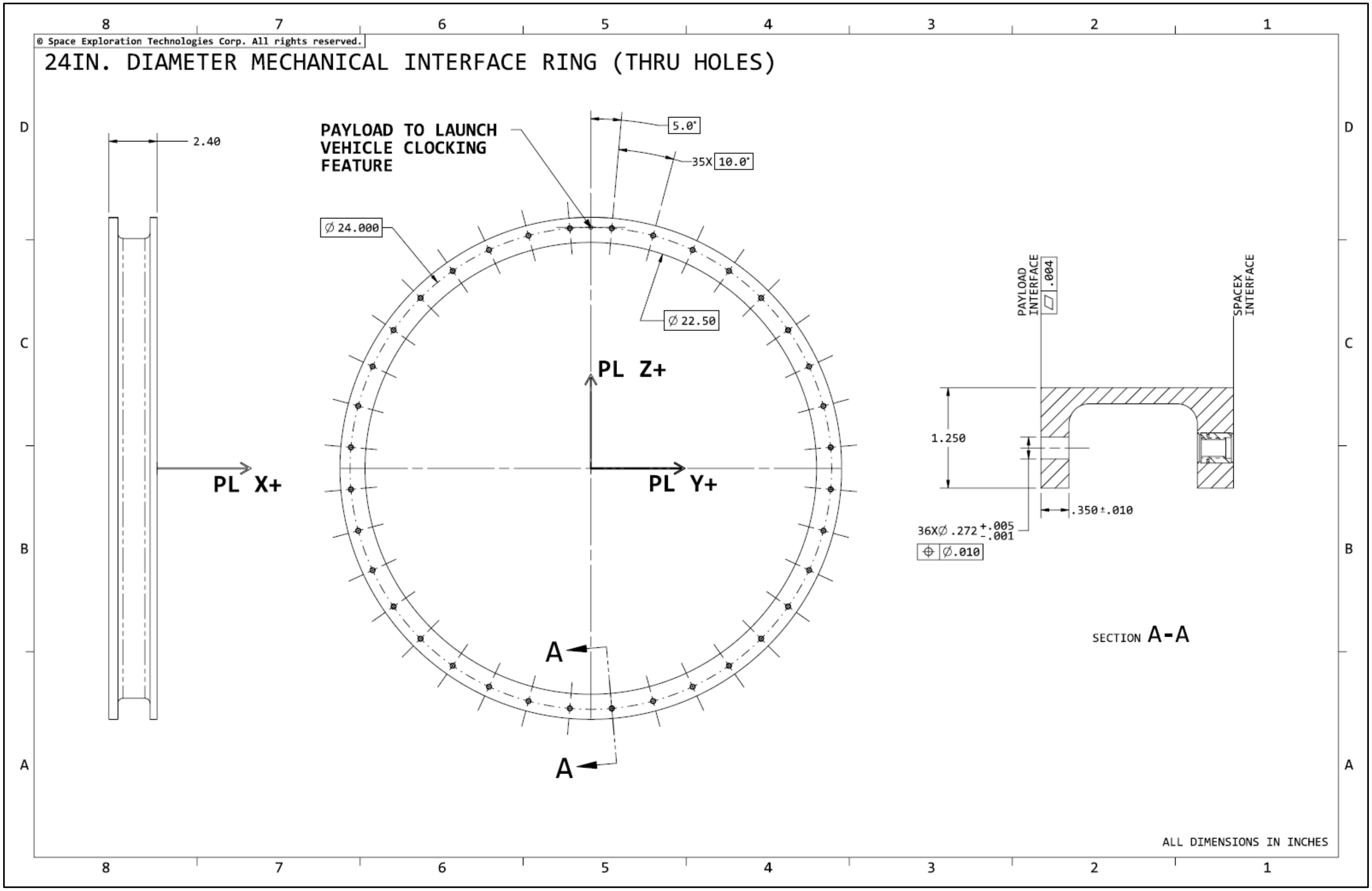

Figure A-4: 24" Diameter Mechanical Interface Ring (Thru-Holes)

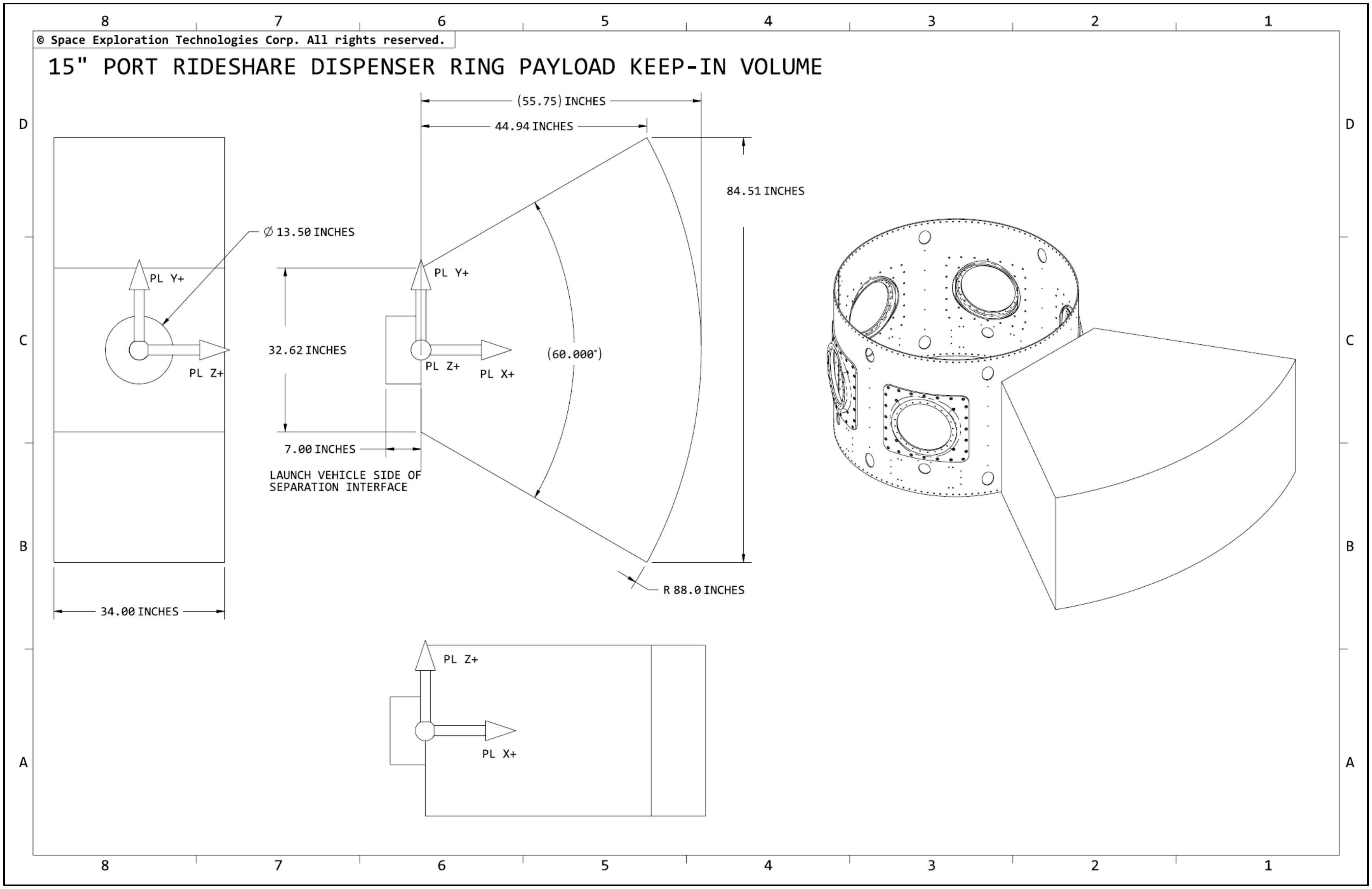

Figure A-5: Rideshare Dispenser Ring 15" Diameter Mechanical Interface Volume Drawing

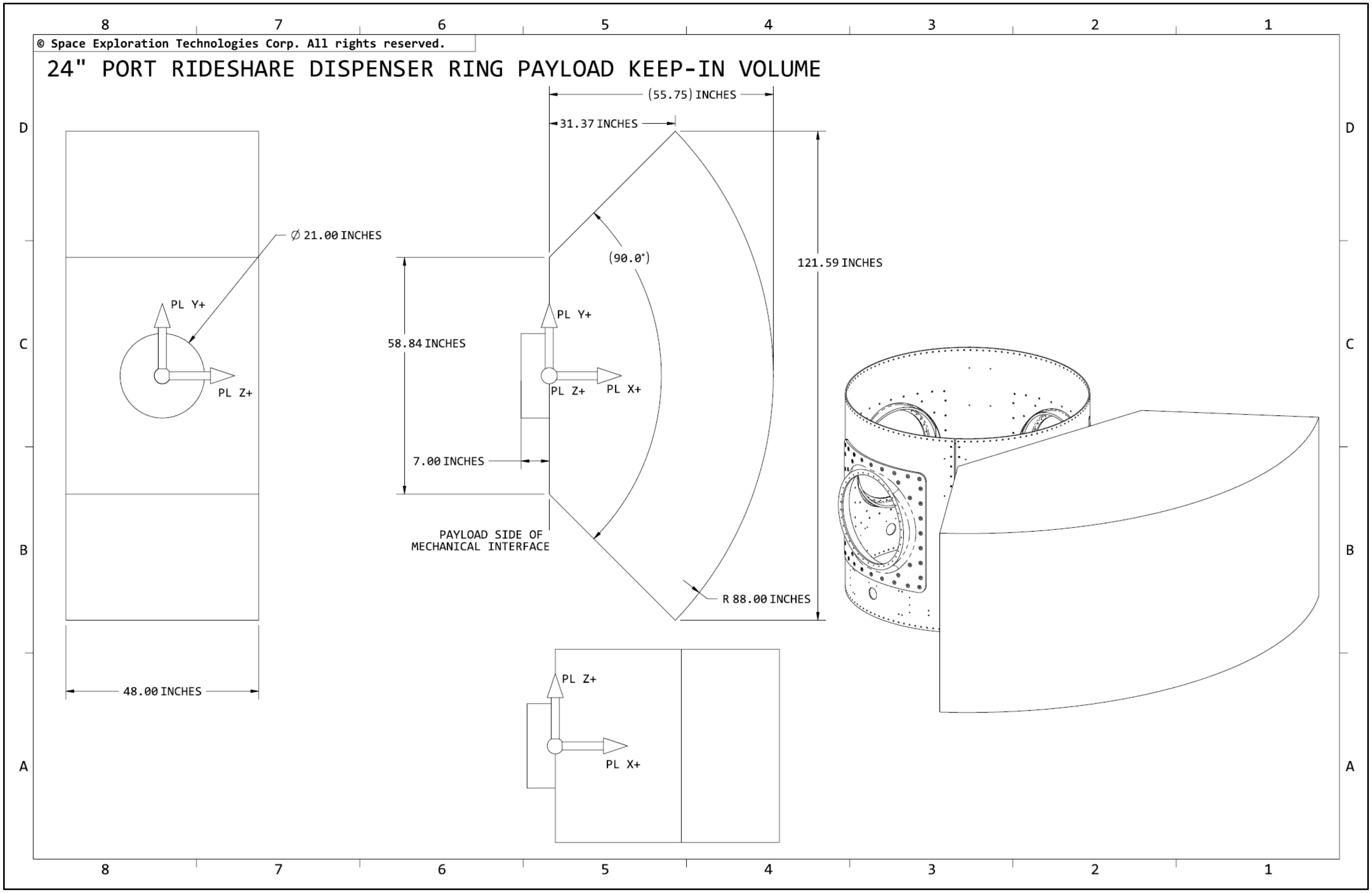

Figure A-6: Rideshare Dispenser Ring 24" Diameter Mechanical Interface Volume Drawing

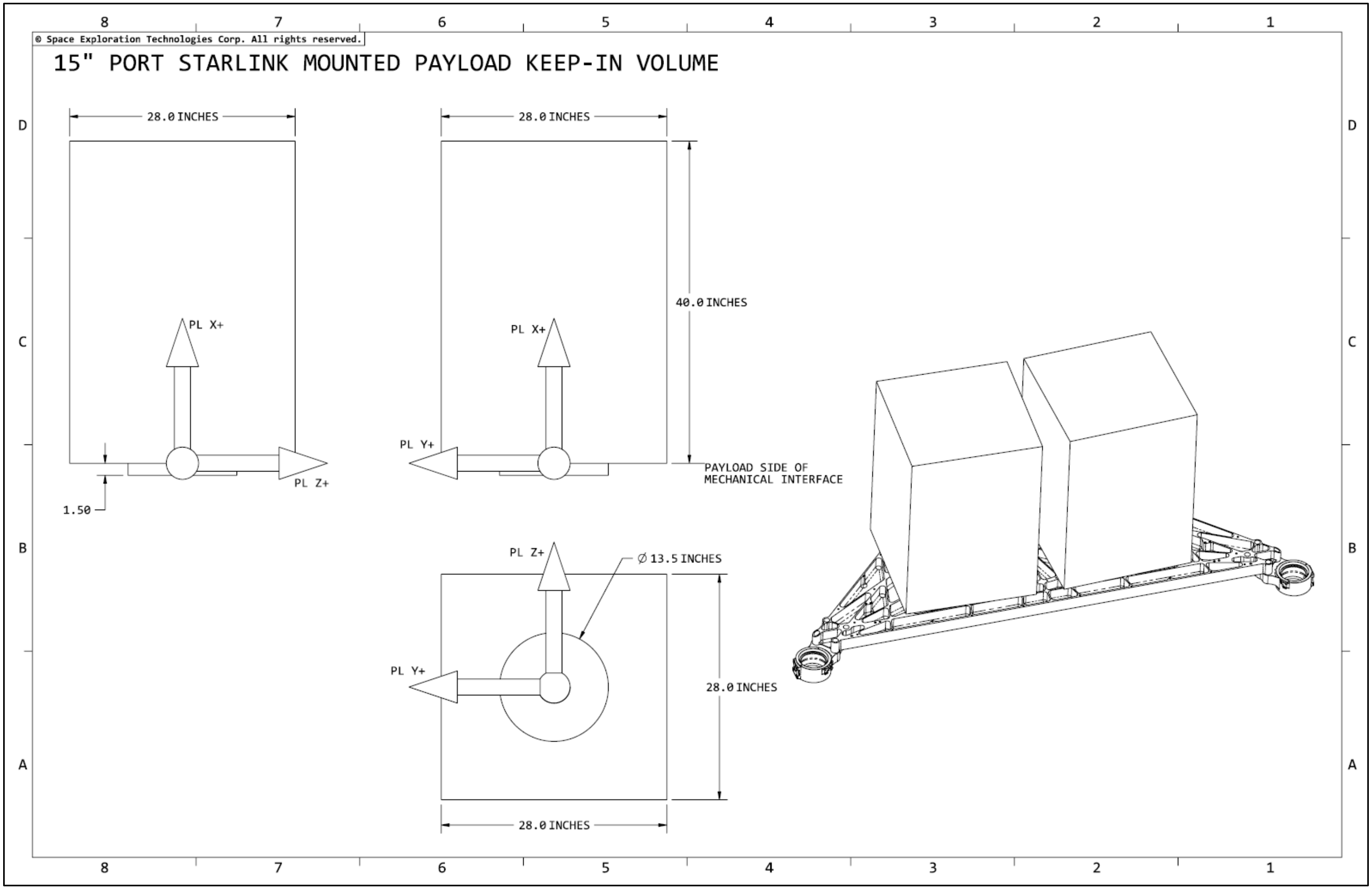

Figure A-7: Starlink Adapter 15" Diameter Mechanical Interface Volume

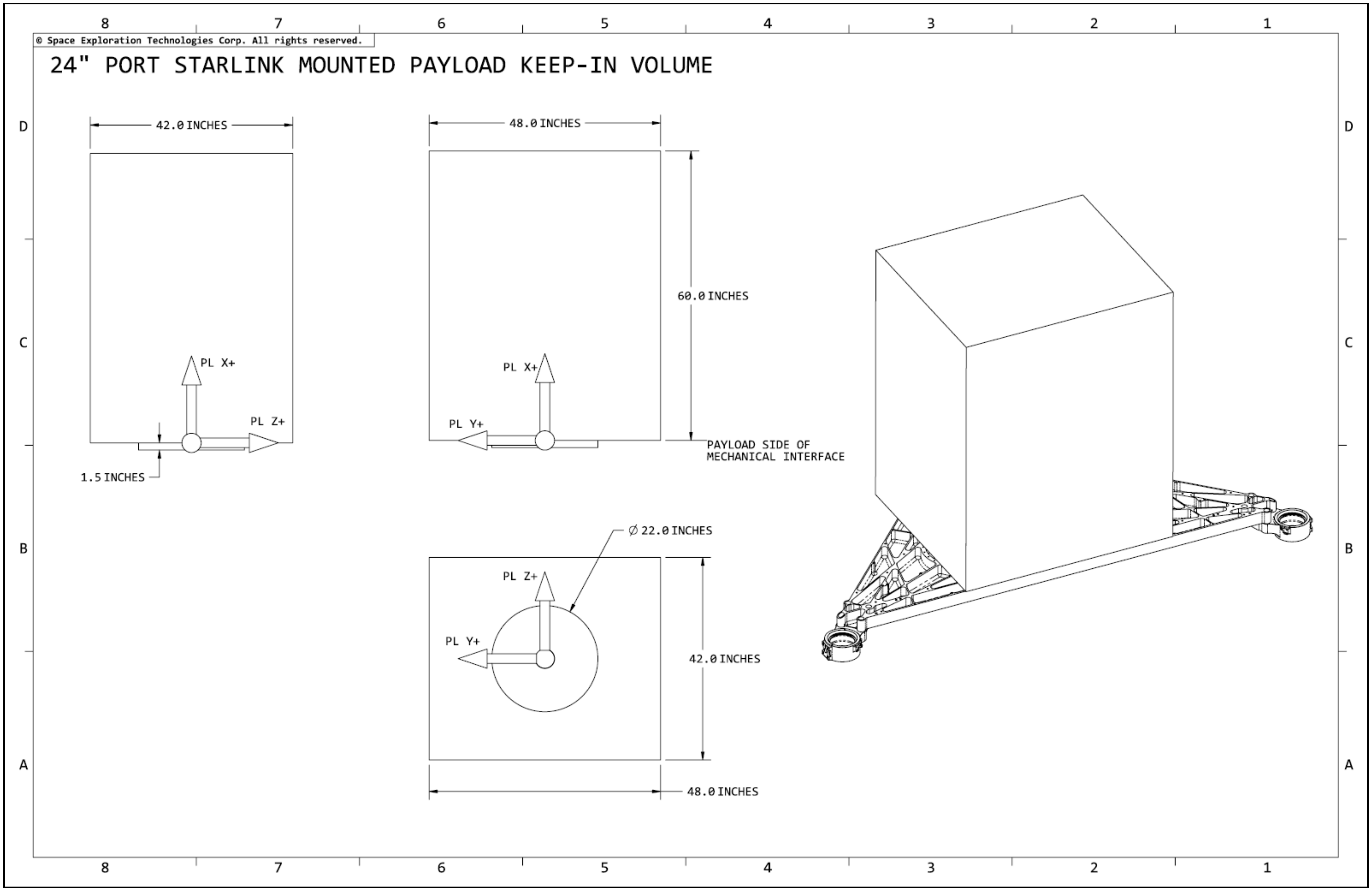

Figure A-8: Starlink Adapter 24" Diameter Mechanical Interface Volume

APPENDIX B: PAYLOAD DYNAMIC MODEL REQUIREMENTS

An analysis may be run to generate predictions of loads. The environments discussed in Section 3.3 are intended to be enveloping for Payloads, thus no delivery of Payload results is guaranteed, but may be provided in the interest of Mission assurance. The Payload dynamic model must be provided to SpaceX as a single-point interface, Craig-Bampton reduced model.

Payload Craig-Bampton Model Definition

Model Requirements:

- The units of the model must be clearly defined (English or SI)
- The model must be a single point interface modal model (see Interface Requirements)
- The Payload coordinate system must follow the coordinate system described in Section 4.1.3
- The model must be Craig-Bampton formatted
- Modal damping must be specified (see Damping Definition section)
- Any uncertainty factor applied to the modal responses must be defined (see Uncertainty Factor section)
- The model must have frequency content up to 150 Hz
- All output requests must be clearly defined (see Analysis Outputs section)
- The model must be an accurate, in good faith, representation of the Payload including primary and secondary structures

Interface Requirements:

- The single-interface node to the Launch Vehicle must remain physical with six degrees of freedom
- The Payload coordinate system described in Section 4.1.3 must be used for the boundary interface node output degrees of freedom
- Clampband and Lightband-style interfaces must be included in the Payload model Craig-Bampton reduction with a single-interface node to the Launch Vehicle remaining physical with six degrees of freedom
- All grid points (in the DTM) for which fairing relative deflections are desired must include all three translations sequentially. If an acceleration-based DTM is provided for Launch Vehicle to Payload relative deflection calculations, then the displacement-based portion must also be provided

Matrix Requirements:

- The model must be delivered in a NASTRAN, Formatted .op4 file and must include the stiffness and mass matrices as the first two matrices (example NASTRAN deck assign statement below)

```
ASSIGN OUTPUT4='Payload.op4',
UNIT=501,FORMATTED,DELETE
```

Example NASTRAN statement for providing matrices

- If the Payload has structures sensitive below 50Hz, the model may include Output Transformation Matrices (OTMs) to recover response of these items
- The mass and stiffness matrices (M and K, respectively) must be provided as complete matrices
- The M and K matrices must be defined as shown below.
    - i are the modal degrees of freedom
    - b are the boundary degrees of freedom
    - ω_i^2 is a diagonal matrix of the eigenvalues
    - K_{bb} is the stiffness from the boundary degrees of freedom

$$M = \begin{bmatrix} M_{bb} & M_{bi} \\ M_{ib} & I \end{bmatrix}, K = \begin{bmatrix} K_{bb} & 0 \\ 0 & \omega_i^2 \end{bmatrix}$$

- OTM a.k.a. Data recovery matrices (DRM) used to recover Payload responses (R) must be in one of the three forms shown below, where $\ddot{x}$ are accelerations and x are displacements.

$$\{R\} = [DRM1]\begin{Bmatrix}\ddot{x}_b\\ \ddot{x}_i\end{Bmatrix}$$

$$\{R\} = [DRM2]\begin{Bmatrix}x_b\\ x_i\end{Bmatrix}$$

$$\{R\} = [DRM1]\begin{Bmatrix}\ddot{x}_b\\ \ddot{x}_i\end{Bmatrix} + [DRM2]\begin{Bmatrix}x_b\\ x_i\end{Bmatrix}$$

  - Responses may be recovered using a $DRM1$ (acceleration transformation matrix), a $DRM2$ (displacement transformation matrix), or using both a $DRM1$ and a $DRM2$.
  - DRM1 and DRM2 must each be provided as separate matrices.
  - Load transformation matrices for element forces, pressures, stresses, etc. must be recovered with either a $DRM1$ (single or multiple point interface models), or using both a $DRM1$ and a $DRM2$ (multiple point interface models only).
- Total number of recoveries will be limited to 100 rows.
- Definition of the Craig-Bampton model rows and columns must be provided to facilitate coupling of the Payload to Launch Vehicle model.
- Labels for the rows of the (DRM) must be provided for inclusion in results tables.
- All LTM matrices must be defined such that they produce loads when multiplied by accelerations (not in g's) and displacements: e.g. inch/sec2 and rad/sec2 and inch and radian or other consistent units.

Analysis Outputs

No delivery of Payload results is guaranteed, but may be provided in the interest of Mission assurance. If provided, the following CLA outputs are delivered in Microsoft Excel and are reported by load case unless otherwise specified:

- Payload Net-CG response max/min table
- OTM response max/min tables*
- Interface force max/min tables
- Interface sine vibe curves with Q specified by Customer
- Relative displacements (between Payload and fairing)

* OTM = Output Transformation Matrix. May also be referred to as a DRM (Data Recovery Matrix). OTMs can include DTM (Displacement Transformation Matrix), ATM (Acceleration Transformation Matrix), LTM (Load Transformation Matrix) and others.

The output coordinate system of the interface force max/min tables and the interface sine-vibe curves will the coordinate system of the Payload, as described in Section 4.1.3.

If outputs in any other coordinate system are desired, then the Customer must generate and provide such outputs in the ATM and/or LTM response recovery matrices.

Damping Definition

Diagonal modal damping must be defined as a percent of critical (and may vary from mode to mode) unless there is firm rationale why full matrix damping should be exercised, such as the existence of an internal highly damped isolation system with known physical characteristics.

Uncertainty Factor

SpaceX, as a standard practice, will apply a model uncertainty factor to all responses that reflects Launch Vehicle maturity. However, if Customer desires the application of a larger model uncertainty factor, this must be specifically requested. Under no circumstance will the model uncertainty factor be less than that used in SpaceX standard practice.

Documentation

SpaceX requests that the Customer's dynamic model be accompanied by documentation that includes:

1. Definition of units used (SI or English).
2. Location of all interface grids in Payload coordinate system.
3. Comparison of unreduced (FEM) and condensed (Craig-Bampton) models.
    a. Mass.
    b. Center of gravity relative to interface.
    c. Strain energy.
    d. First seven modes of free-free analysis.
    e. Modal analysis, including modal effective mass.
4. A list of all frequencies.
5. Pictures and/or descriptions and frequencies of the first few mode shapes (including the three fundamental modes in X, Y, and Z).
6. Definition of damping.
7. Definition of the model response (dynamic) uncertainty factor.
8. Definition of output format and requests, e.g., interface loads, interface accelerations, net CG loads, internal Payload loads, shock response spectra (SRSs), etc.
9. If internal Payload responses are requested, provide appropriate DRMs (ATMs, DTMs, and LTMs) as well as tables defining the rows of these matrices.
10. Definition of any Payload limit loads, including primary structure and component level, in order for SpaceX to evaluate the CLA results (net CG, interface loads, and ATM/DTM/LTM) and determine if the CLA indicates an exceedance of Payload structural capability.

The above list is not all-inclusive, and Customer is encouraged to provide additional information that will assist SpaceX in processing the Payload dynamic model for the coupled loads analysis.

APPENDIX C: PAYLOAD CAD MODEL REQUIREMENTS

Customer must provide SpaceX a CAD model of the Payload in STEP or IGES format. SpaceX will integrate the Payload CAD model with the models of the Launch Vehicle second stage, Mechanical Interface Ring, and fairing for visualization, integration, clearance check, and operations development purposes.

SpaceX uses Siemens NX for CAD processing and, upon mutual agreement of the Parties, can accept Customer CAD models in a Parasolid file, the native format of NX.

The Payload CAD model must be simplified by the Customer and focus primarily on outer mold line and interface fidelity (to facilitate efficient model manipulation and processing). Customer must limit their CAD model complexity, as requested by SpaceX, to only the details and interfaces necessary for integration with the Launch Vehicle, while retaining the basic structure of the Payload. Spurious information must be removed from the model by Customer before transmission to SpaceX (an example of unnecessary detail is thousands of bodies within a CAD model representing individual cells on a solar array).

The Payload CAD model must include the following information in order for SpaceX to analyze clearances, prepare compatibility drawings, and produce Payload ICD images:

- Payload interface to Launch Vehicle:
    - Payload mechanical interface to Launch Vehicle
    - Separation connectors and associated brackets
    - Pusher pads
- Components subject to review for clearance analysis:
    - External components to review for clearance to fairing volume (e.g. solar array panels, aft and forward antenna components, reflectors)
    - Any components in the immediate vicinity (<20 cm) of the interface components above
    - Any components which protrude below the separation plane
- Any points which may require access after encapsulation
- Simple Payload bus structure.

The Payload CAD model must not include:

- Internal Payload or bus components
- Spurious details, including individual solar array cells, fasteners, antenna, reflectors, etc., that do not add to the understanding of external volumes.

APPENDIX D: PAYLOAD ENCAPSULATION & LAUNCH READINESS CERTIFICATES

The Payload Customer must provide Payload readiness certification letters prior to Payload encapsulation and prior to Launch Vehicle roll out to the Launch Pad. The letter templates below are broken out into three possible scenarios:

- Scenario A: No battery charging
- Scenario B: Battery charging prior to Launch Vehicle rollout to Launch Pad
- Scenario C: Battery charging at Launch Pad (Optional Service)

ENCAPSULATION READINESS LETTER TEMPLATE

[Insert Company Logo]

[Insert Company Name]
[Insert Company Address]

To:	Space Exploration Technologies Corp. (SpaceX)
From:	[Insert Company Name]
Date:	[Insert Date]
Subject:	Encapsulation Readiness Certification Letter

[Insert Company] certifies that the [Insert Name] Rideshare Payload is ready for fairing encapsulation. [Insert Company] confirms the following:

1. All Remove Before Flight (RBF) items have been removed from the Rideshare Payload
2. All Add Before Flight (ABF) items have been installed on the Rideshare Payload
3. All closeout pictures have been taken and reviewed
4. All mechanical and electrical connections between the [Insert Name] Rideshare Payload and the SpaceX Rideshare dispenser hardware is complete
5. No entry into the fairing is required once the Rideshare Payload is encapsulated

[CHOOSE ONE OF THE FOLLOWING]

A. [Insert Company] certifies that the [Insert Name] Rideshare Payload batteries were last charged to full capacity on [Insert Date] at [Insert Time] [Insert Local Time Zone] and will remain flight ready for up to 45 days past the last charge.
B. [Insert Company] certifies that the [Insert Name] Rideshare Payload batteries will be fully charged prior to Launch Vehicle roll out to the Launch Pad and remain flight ready for up to [TBD] days past the last charge.
C. [Insert Company] certifies that the [Insert Name] Rideshare Payload batteries will be fully charged while connected to the Launch Pad and that charging will be terminated prior to L-1 hour.

Sincerely,

[Insert Signature]

[Insert Company]

LAUNCH READINESS LETTER TEMPLATE

[Insert Company Logo]

[Insert Company Name]
[Insert Company Address]

To: Space Exploration Technologies Corp. (SpaceX)
From: [Insert Company Name]
Date: [Insert Date]
Subject: Launch Readiness Certification Letter

[Insert Company] certifies that the [Insert Name] Rideshare Payload is GO for launch on the Falcon 9 rocket, including conforming to all applicable Payload safety requirements of the Air Force Space Command Range Safety User Requirement Manual (AFSPCMAN 91-710), as tailored for the Mission.

[Insert Company] has reviewed all open issues and risks and certifies that there are no current constraints to Launch. If there are any new issues that arise prior to Launch, [Insert Company] will inform SpaceX.

[CHOOSE ONE OF THE FOLLOWING]

A. As certified in the Encapsulation Readiness Certification Letter dated [Insert Date], the [Insert Name] Rideshare Payload batteries were last charged to full capacity on [Insert Date] at [Insert Time] [Insert Local Time Zone] and will remain flight ready for up to 45 days past the last charge.
B. [Insert Company] certifies that the [Insert Name] Rideshare Payload batteries were last charged on [Insert Date] at [Insert Time] [Insert Local Time Zone] to full capacity and will remain flight ready for up to [TBD] days past the last charge.
C. [Insert Company] certifies that the [Insert Name] Rideshare Payload batteries will be fully charged while connected to the Pad and that charging will be terminated prior to L-1 hour.

Sincerely,

[Insert Signature]

[Insert Company]

APPENDIX E: DELIVERY FORMAT OF SEPARATION STATE VECTOR

```
SpaceX OPM output (generated YYYY-MM-DD-Day-HH-MM-SS):

All orbital elements are defined as osculating at the instant of the printed state.
Orbital elements are computed in an inertial frame realized by inertially freezing the WGS84 ECEF
frame at time of current state. This OPM is provided based on flight telemetry from the second-
stage, and therefore represents the state of the second-stage and not the state of any other
body. Any position, velocity, attitude, or attitude-rate differences between the second-stage and
any other body need to be accounted for by the recipient of this OPM.

UTC time at liftoff:                 DOY:HH:MM:SS.SS
UTC time of current state:           DOY:HH:MM:SS.SS
Mission elapsed time (s):            +XX.XX
ECEF (X,Y,Z) Position (m):           +XXXXXX.XXX, +XXXXXXXX.XXX, +XXXXXXX.XXX
ECEF (X,Y,Z) Velocity* (m/s):        +XXXX.XXX, +XXXX.XXX, +XXXX.XXX
LVLH to BODY quaternion (S,X,Y,Z):   +X.XXXXXXX, +X.XXXXXXX, +X.XXXXXXX, +X.XXXXXXX
Inertial body rates (X,Y,Z) (deg/s): +X.XXXXXXX, +X.XXXXXXX, +X.XXXXXXX
Apogee Altitude** (km):              +XXXXX.XXX
Perigee Altitude** (km):             +XXX.XXX
Inclination (deg):                   +XX.XXX
Argument of Perigee (deg):           +XXX.XXX
Longitude of the Asc. Node*** (deg): +XXX.XXX
True Anomaly (deg):                  +XX.XXX

Notes:
*     ECEF velocity is Earth relative

**   Apogee/Perigee altitude assumes a spherical Earth, 6378.137 km radius

***  LAN is defined as the angle between Greenwich Meridian (Earth longitude 0) and the ascending
      node
```


APPENDIX F: PAYLOAD LICENSING CERTIFICATION

[Insert Company Logo]

[Insert Company Name]
[Insert Company Address]

To: Space Exploration Technologies Corp. (SpaceX)
From: [Insert Company Name]
Date: [Insert Date]
Subject: Payload Licensing Certification Letter

[Insert description of Payload]

[Insert Company] certifies that:

(1) it has obtained all required Payload Licenses, and
(2) it has reviewed and understood the Hazardous Materials Table found at https://www.law.cornell.edu/cfr/text/49/172.101 and accurately provided to SpaceX the list of Hazardous materials found within the Payload, and
(3) all information submitted to SpaceX and/or to licensing agencies regarding its Payload is complete and accurate.

Sincerely,

[Insert Signature]

[Insert Company]

APPENDIX G: DELIVERABLES DESCRIPTIONS

Table G-1: SpaceX Deliverables Description

Associated Milestone	SpaceX Deliverables	Format	Description
Acceptance of Request	Acceptance of Request	Email	Acceptance of Request
	TAA questionnaire or Export Compliance Agreement	Document	Representations and certifications for Customer to complete for TAA application (if not already provided prior to Agreement signature) or Export Compliance Agreement between US parties and SpaceX.
	Payload questionnaire	Document	Request for preliminary information on the Payload that SpaceX will use in support of early internal analyses and program deliverables.
Mission Integration Kickoff	ICD template	Document	Template of the ICD containing placeholders for Mission-specific requirements and other interface information to be developed and populated during the course of Mission integration. The ICD defines the Mission requirements and interfaces between Customer and SpaceX systems.
	Launch Range introduction and Payload Range Safety requirements	Slides	Introduction to the Launch Range, Launch Range processes, and how SpaceX/Customer/Launch Range will interface with each other during the campaign. Customer is also provided a copy of the safety regulations at the Launch Site.
	Range Safety document templates	Documents	Document templates for the Range Safety deliverables.
	Payload qualification and acceptance approach templates	Documents	Templates to verify Payload compatibility for the contamination requirements found in Section 0 and to provide the test plan as outlined in Section 3.4 for each Payload Constituent. The test plan template serves as a cover sheet for subsequent test and/or analysis reports delivered by the Customer as required in the Mission-specific ICD.
	Payload electrical pinout worksheet	Spreadsheet	A spreadsheet that describes the Launch Vehicle to Payload electrical harness properties and pin-outs.
	Payload mass properties and deployment characteristics template	Spreadsheet	A template for the Customer to complete which describes the Payload mass properties, including its center of gravity, moments of inertia and products of inertia for each deployment within the Payload as well as the stay-behind portion. The template also defines deployment characteristics such as cross-sectional area and separation energy.
	Customer built wire harness build guides	Documents and Spreadsheet	Detailed documents that describe the requirements for Customer built harnesses; one for general requirements and one for Rideshare specific requirements, as well as a spreadsheet to define tie down locations on SpaceX hardware for Customer built harness routing.
Interface Definitions	Payload-to-LV electrical interface	Spreadsheet	A spreadsheet capturing the electrical interfaces of the Payload to the Launch Vehicle and documenting the end-to-end pin-out of the SpaceX and Customer built harnessing, including electrical characteristics of each pin.
	Payload-to-LV mechanical interface	CAD file	CAD model of the SpaceX supplied Mechanical Interface Ring as well as the Rideshare dispenser defined for the Payload.
	ICD Draft	Document	Preliminary draft of the ICD utilizing inputs from Customer for Mission-specific requirements and other interface information to be developed and populated during the course of Mission integration. The ICD defines the Mission requirements and interfaces between Customer and SpaceX systems.

Associated Milestone	SpaceX Deliverables	Format	Description
Mission Planning	Launch Campaign planning package	Documents	Launch campaign planning resources to support Customer deliverables including launch campaign attendee badge information, licensing and insurance information, and logistics information.
Mission Integration Analyses	Predicted Orbit Injection Report	Slides	Predicted state vector information, based on a nominal trajectory optimized for the Mission. This state vector will be provided in SpaceX-defined format (reference Appendix E).
	CLA results (if required)	Slides	CLA results presented as described in Appendix B.
	Payload venting analysis results (if required)	Slides	Maximum predicted fairing venting analysis, based on worst-case Payload Archimedes volume showing the predicted internal pressure (psi) and depressurization rate (psi/sec) of the fairing compartment as a function of time for the duration of the ascent trajectory.
	Payload separation analysis results (if required)	Slides	Results of the separation analysis predicting the maximum linear and angular separation rates of the Payload upon separation from the Launch Vehicle.
	Payload clearance analysis results (if required)	Slides	Identification of locations with minimal Payload to Launch Vehicle or Payload to Co-Payload(s) clearance, based on CAD modeling, as well as identification of nominal and worst-case clearance locations based on dynamic loss of clearance, as predicted by the CLA.
	Launch integration schedule (preliminary)	Spreadsheet	Schedule of Launch Site operations identifying Payload stand-alone activities and combined Payload/Launch Vehicle operations.
	Launch Campaign Plan (preliminary)	Document	Plan for Payload integration and Launch, including the facilities to be used and the operations to be performed for both Launch Vehicle and Payload processing, including implementation of Customer processing requirements.
	ICD Draft (update)	Document	Updated draft of the ICD to be reviewed by the Parties. Contains Mission requirements and interface information.
Mission Integration Analyses Final	Trajectory analysis results	Slides	SpaceX will develop a nominal trajectory optimized for the Mission. This nominal trajectory will be used to determine the nominal injection state vector, develop the Launch Window, define the mission level deploy order and timeline, and assess free molecular heating. SpaceX will conduct a Monte Carlo analysis to formally quantify dispersions on the injection orbit and Launch Vehicle performance. These Monte Carlo results will serve as the verification for orbit injection accuracy requirements and Launch Vehicle performance margins. This analysis includes collision avoidance.
	Mission analysis updates (if applicable)	Various	Updated analyses performed by mutual agreement of the Parties (for example, revised trajectory results following a significant deviation of measured Payload and/or Co-Payload(s) mass properties from the predicted mass properties). SpaceX does not provide analysis updates for minor changes to Customer models or inputs (for example, nominal reduction of Payload mass properties uncertainty due to Payload maturity).
Launch Campaign Readiness Review	Launch integration schedule (update)	Spreadsheet	Updated schedule of Launch Site operations identifying Payload stand-alone activities and combined Payload/Launch Vehicle operations.
	Launch Campaign Plan (update)	Document	Updated plan for Payload arrival, integration and Launch, including the facilities to be used and the operations to be performed for both Launch Vehicle and Payload processing.
	ICD revision for signature	Document	Final revision of the ICD to be signed by the Parties.
	Launch Range readiness information	Slides	Confirmation that the Launch Range is prepared to receive the Payload and begin Launch Site activities.
	Verification of compliance to ICD requirements	Document or slides	Lists the ICD requirements and verification status/evidence in accordance with the approved verification matrix within the ICD.

Associated Milestone	SpaceX Deliverables	Format	Description
Payload Arrival	Launch Campaign arrival briefing	Slides	Briefing to the Customer providing information about working at the Launch Site, including contact information, security, SpaceX policies, transportation, medical, facility overview, hazardous operations and natural hazards (e.g. lightning), and personnel safety.
Launch Campaign	Hazardous operations planning meeting (if required)	Meeting	A meeting to plan and coordinate any hazardous operations that the Payload must undergo at the Launch Site.
	Electrical checkout results	Document or Spreadsheet	Documents detailing the results of the SpaceX electrical checkouts performed on the harnessing which interfaces with the Payload.
	Daily environmental reports	Email	Daily reports of facility temperature, relative humidity and particle count.
	Daily Launch Campaign schedule	Spreadsheet	Daily updates to the Launch Campaign schedule as coordinated with the Customer.
Launch Readiness	Launch Vehicle readiness certificate	Document	Signed confirmation from SpaceX to the Customer that the Launch Vehicle is ready for countdown and Launch.
Launch	Orbit injection report	Electronic Delivery	Provides operational state vector information, based on best available telemetry during the flight. This state vector will be provided in SpaceX-defined format (reference Appendix E); Customer is solely responsible for conversion, if necessary, of the data into a Customer-preferred format.

Table G-2: Customer Deliverables Description

Associated Milestone	Customer Deliverables	Format	Description
Acceptance of Request	Request for Rideshare Launch Services	Website	Request for Rideshare Launch Services.
	Point of Contact	n/a	Identification for the Customer point of contact that will interface with the SpaceX mission manager.
Mission Integration Kickoff	Completed TAA questionnaire or Export Compliance Agreement	Document	Representations and certifications from Customer for Technical Assistance Agreement (TAA) application (if not already completed prior to the Kickoff) or signed Export Compliance Agreement.
	Completed Payload questionnaire	Document	Preliminary information on the Payload provided by the Customer for SpaceX use in support of early internal analyses and program deliverables.
	Payload CAD models	CAD file	Preliminary Payload CAD model, in accordance with Appendix C.
	Payload constituents	Document	The Customer's list of Payload Constituents submitted to SpaceX (in accordance with Appendix H) will include the following information: component name, manufacturer, country of origin, owner, operator, country of operator, end user(s), country of end user(s), end use, general description, propulsion type (if applicable), and quantity (if more than one identical component).
Mission Integration Analysis Inputs	Payload inputs to ICD	Document	Payload interface information and system descriptions to be captured in the ICD in the template format provided by SpaceX.
	Payload CAD model update (if applicable)	CAD files	Updated Payload CAD model, in accordance with Appendix C.
	Payload dynamic model	Dynamic model files	Payload dynamic model, in accordance with Appendix B.
	Payload electrical interface pinout	Spreadsheet	Customer inputs provided in the SpaceX provided template that defines the Launch Vehicle to Payload electrical harness properties and pin-outs
	Payload mass properties and deployment characteristics	Spreadsheet	Current best estimate of the Payload mass properties (mass, center of mass, moments of inertia, products of inertia) and deployment characteristics (size, deploy energy) using the template provided by SpaceX.
	Completed Payload environmental test matrix	Document	Provide the test plan approach compared to Section 3.4 for each Payload Constituent using template provided by SpaceX.
Range Safety Submission	Rideshare Range Safety Checklist	Document	A checklist defining the Payload design and hazardous subsystems. For subsystems, depending on complexity and hazard level, additional documentation may be required such as 91-710 Tailoring, Missile System Prelaunch Safety Packages (MSPSP), and certification data for hazardous systems.
	Payload Program Introduction	Document	A simplified and high-level overview of the Payload and its associated hazardous systems in a condensed format for Launch Range safety authorities (template provided by SpaceX). The PI provides quick reference on Payload appearance, size, mass, propellants, batteries, pressure vessels, heat pipes, and radiating sources. Detailed information about the Payload is provided in the MSPSP.
Mission Planning	Inputs to Launch Site activity planning	Document	Description of Customer Launch Site activities including Payload stand-alone processing, requested Launch Site services, and Launch Site interfaces. Payload mating GSE CAD model and summary of operations for final mate to Rideshare dispenser.
	Payload updates to ICD	Document	Updated Payload interface information and system descriptions to be captured in the ICD in a format provided by SpaceX.

Associated Milestone	Customer Deliverables	Format	Description
Mission Planning	Separation verification	Document	Customer provides an analysis verifying that Payload Constituents deployed from the Launch Vehicle are packaged in such a way to meet the separation requirements outlined in Section 2.4.
Range Safety Submission	Payload Ground Operations Plan	Document	The Payload Ground Operations Plan (GOP) provides a detailed description of the hazardous and safety critical operations associated with the Payload and its GSE. The Payload GOP contains a description of planned operations and the hazard analysis of those operations. The Customer's GOP must be prepared in accordance with 91-710 Vol 6, attachment 1 for SpaceX to submit to the Launch Range safety authority for review and approval.
	Payload 91-710 tailoring (if required)	Document	Tailoring provides a means for formulating a Payload-specific edition of AFSPCMAN 91-710 (Volumes 1, 3, and 6) and documents whether or not the Customer will meet applicable safety requirements as written or achieve an equivalent level of safety through a requested and approved alternative approach. The Customer's tailoring requests must be prepared in accordance with 91-710 Vol 1, attachment 1 for SpaceX to submit to the Launch Range safety authority for review and approval.
	Payload MSPSP (if required)	Document	Payload safety information providing the Launch Range safety authority with a description of hazardous and safety-critical support equipment and flight hardware associated with the Payload. The Customer's MSPSP must be prepared in accordance with 91-710 Vol 3, attachment 1 for SpaceX to submit to the Launch Range safety authority for review and approval.
	Certification Data for Payload Hazardous Systems (if required)	Document	Certification data for Payload hazardous systems. A system is deemed hazardous if it includes any of the following: pressure vessels (over 250 psi), batteries, hazardous materials, non-ionizing and ionizing radiation systems, hazardous propulsion systems, or ordnance. Data must also be provided for GSE (for example, lift slings).
Final Mission Integration Analysis Inputs	Payload mass properties and deployment characteristics (update)	Document	Customer to provide SpaceX updated (best available) Payload mass properties and deployment characteristics inputs for the Monte Carlo analysis of the nominal trajectory using the Payload mass properties template provided by SpaceX.
	Payload Verification Test/Analysis Reports	Document	Customer to provide to SpaceX final environmental verification test and/or analysis reports in order to prove compliance to Section 3.4 and in accordance with the SpaceX approved Payload environmental test matrix.
Range Safety Submission	Payload 91-710 Compliance Letter	Document	Signed confirmation from Customer to SpaceX that the Payload complies with all safety requirements.
	Ground Operating Plan Hazardous procedures	Document	Payload procedures provide detailed, systematic descriptions of the manner in which Customer's hazardous and safety critical operations will be accomplished at the Launch Site. These procedures are the basis from which approval to start hazardous or safety critical operations are obtained from the Launch Range safety authority. The Customer's hazardous procedures must be prepared in accordance with 91-710 Vol 6, attachment 2 for SpaceX to submit to the Launch Range safety authority for review and approval. Customer is strongly encouraged to deliver procedures earlier than 45 days before hardware arrival at the Launch Site. Procedures must be in English.
Launch Campaign Readiness Review	Verification of Payload compliance to ICD requirements	Document	Payload verification status/evidence in accordance with the approved verification matrix within the ICD.

Associated Milestone	Customer Deliverables	Format	Description
Launch Campaign Readiness Review	Hourly Schedule of daily Launch Site operations	Spreadsheet	The Payload operations schedule provides day-by-day insight to Customer's stand-alone Payload processing operations at the Launch Site. SpaceX creates combined schedules, arranges SpaceX support to Customer, and coordinates Launch Range safety support based on Customer's operations schedule including scheduling information of hourly hazardous Payload operations. Required by the Launch Range safety authorities for awareness and oversight of hazardous Payload operations.
	Plan for Payload and GSE arrival at the Launch Site	Document	The Payload and GSE arrival plan describes the methods and logistics of Customer's hardware arrival at the Launch Site.
	Propellant/Pressurant arrival information (if applicable)	Document	The Payload propellant and/or pressurant arrival plan describes the methods and logistics of Customer's propellant and/or pressurant shipment to the Launch Site, if applicable.
	Badging Paperwork for All Customers	Document	Customer delivers the names and personnel information (including passport/visa scans and photos necessary for the appropriate Launch Site badging (for example, U.S. Air Force or NASA badging data requirements).
	Licensing inputs for Mission	Document	Customer provides inputs for licenses applied for by SpaceX, including the Hazardous Materials list (SpaceX provided template), webcast approval letter (SpaceX provided template), and identification of any open air RF testing required at the Launch Site.
	Payload insurance and cross-waivers	Document	Evidence of insurance for the Payload, Customer property, equipment and personnel (with express waivers of subrogation as to SpaceX and its Related Third Parties). Evidence that the cross-waivers have been extended to (i) its Payload manufacturer(s); (ii) Related Third Parties with any ownership interest in the Payload; (iii) Customer's direct customers for the Payload; and (iv) any other Related Third Parties, respective contractors, subcontractors and insurers, as requested by SpaceX. Each must waive (in writing) the right to sue or otherwise bring a claim against SpaceX or SpaceX's Related Third Parties, any Co- Payload Customers or their Related Third Parties, or the U.S. Government or its contractors or subcontractors for any injury, death, property loss or damage (including loss of or damage to the Payload, the any Co-Payload(s), the Launch Vehicle, or other financial loss) sustained by them or any of their employees, officers, directors or agents, arising out of or related to activities relating to the performance of the Agreement.
	Launch and In-Orbit Insurer Subrogation Waiver (if applicable)	Document	If Payload insurance is procured, Customer to provide evidence that the insurer has waived subrogation rights.
	Payload mass properties - measured	Document	If Payload is not being fueled at the Launch Site, measured Payload mass properties, including analytical adjustments for any non-flight items (e.g. remove-before-flight covers) which remained on the Payload during the final mass properties measurement. The final mass properties must be accurate to better than 0.5% uncertainty.
Payload Shipment	Payload Licensing Certification	Document	Signed confirmation from Customer to SpaceX, in the form of the letter shown in Appendix F that required Payload licensing is in place and information provided to licensing agencies and SpaceX is accurate. Letter provided to SpaceX prior to Payload shipment to the Launch Site.
	Copies of all required on-orbit Payload licenses	Document	Customer to provide proof of all required on-orbit licensing required for Payload Constituents to legally operate in space.

Associated Milestone	Customer Deliverables	Format	Description
Payload Arrival	Launch Site awareness training complete	n/a	All Customer personnel participating in the Launch Campaign complete online Launch Site awareness training prior to arrival at the Launch Site.
Launch Campaign	Payload mass properties - measured	Document	If Payload is being fueled at the Launch Site, measured, final post-fueling Payload mass properties for day-of-Launch configuration (i.e. including installation of system enable plugs and excluding any remove-before-flight items). The final wet mass properties must be accurate to better than 0.5% uncertainty.
Launch Readiness	Payload Launch Readiness Certificate	Document	Signed confirmation from Customer to SpaceX, in the form of the letter shown in Appendix D, that the Payload is ready for countdown and Launch.
Flight Report	Payload operations status	Document	Brief summary of the current Payload status, as well an early operations informational summary.

APPENDIX H: PAYLOAD CONSTITUENTS

Payload Constituent (satellite, separation system, etc.)			
Owner			
Address (including Country) or Owner			
Manufacturer			
Address (including country) of Manufacturer			
Operator			
Address (including country) of Operator			
End User			
Address (including country) of End User(s)			
End Use			
General Description			
Propulsion			
Quantity			

Note: SpaceX may approve or deny one or more of the requested Payload Constituents, including if SpaceX determines it is unable to obtain regulatory approvals. Customer is allowed to propose an alternate Payload Constituent in place of any rejected Payload Constituent. After Mission integration analyses are complete SpaceX may reject a proposed alternate Payload Constituent if the proposed Payload Constituent invalidates the Mission integration analyses (as determined by SpaceX) or invalidates any licensing or regulatory approvals. SpaceX's approval is at the sole discretion of SpaceX while timely approval for all items within the Payload be the sole responsibility of the Customer. Customer's failure to receive approval for any item within the Payload may result in rebooking and associated fees.

APPENDIX I: OPTIONAL SERVICES

SpaceX offers the optional services described in this section for an additional cost above the baseline pricing found at www.spacex.com/rideshare.

Table I-1: Optional Services

<table>
<tr><th>Service</th><th>Description</th><th>Price</th></tr>
<tr><td>Payload Adapter Plate</td><td>SpaceX can provide an adapter plate for Payloads with mechanical interfaces other than 15" or 24" at the Customer request. The Payload adapter plate can accommodate mechanical interface diameters including 8", 11.732", 13", and 18.25". Other Payload mechanical interfaces may be considered, please contact SpaceX for further details.</td><td>$15,000 per plate</td></tr>
<tr><td>Separation System</td><td>SpaceX can provide a separation system for Payloads at the Customer request. Separation systems vary in price depending on the size of the system and require at least a 6-month lead-time for procurement. Separation systems for mechanical interfaces not listed here may be available, please contact SpaceX for further details.</td><td><table><tr><th>Diameter</th><th>Price</th></tr><tr><td>8"</td><td>$230,000</td></tr><tr><td>11.732"</td><td>$250,000</td></tr><tr><td>15"</td><td>$280,000</td></tr><tr><td>24"</td><td>$430,000</td></tr></table></td></tr>
<tr><td>Launch Site Fueling</td><td>Standard Rideshare Launch services do not include provisions for Payload fueling at the Launch Site. Customer may perform fueling operations at the Launch Site that do not require SCAPE, for an additional cost, which includes an additional day of processing at the Launch Site. For any fueling operations that do require SCAPE, please contact SpaceX for further information.</td><td>$35,000</td></tr>
<tr><td>Payload Electrical Connectivity at Launch Pad</td><td>SpaceX accommodates electrical connectivity between Customer EGSE and the Payload during most processing and integration activities up until Launch Vehicle rollout to the Pad. SpaceX can provide electrical connectivity between Customer EGSE and the Payload on the Pad and throughout the Launch countdown including allocation of a customer console for remote monitoring as an optional service.</td><td>Contact SpaceX</td></tr>
</table>

APPENDIX J: DEFINITIONS

"Agreement" refers to the Launch Services Agreement between SpaceX and Customer.

"Acceptance of Request" means the email sent to Customer by SpaceX upon acceptance of the Request for Launch Services submitted by Customer. The Acceptance of Request documents and becomes a part of SpaceX's acceptance of the Agreement between SpaceX and Customer.

"Co-Payload" means a payload of a customer of SpaceX, other than Customer, that is manifested on the same Mission as Customer.

"Co-Payload Customer" means any customer of SpaceX other than Customer that has a payload manifested on the same Mission as Customer.

"CSLA" means the Commercial Space Launch Act of 1988, as amended, 51 U.S.C. §§ 50901-50923 and the regulations issued pursuant thereto, including the Commercial Space Transportation Regulations, 14 C.F.R. Parts 400-460.

"Customer" has the meaning set forth in the Acceptance of Request signature page of the Agreement.

"Dedicated Rideshare" means a mission with only Rideshare Payloads as defined in this document.

"EAR" means the Export Administration Regulations administered by the Bureau of Industry and Security, U.S. Department of Commerce, 15 C.F.R. Parts 730-744, pursuant to the Export Control Reform Act of 2018.

"Excusable Delays" shall mean a delay arising from causes beyond the control of the affected party, including acts of god or government (except to the extent such acts are undertaken by the government that owns or controls a party or of which a party is a part), terrorism, riot, revolution, hijacking, fire, embargo, sabotage, Launch Range 'no go' determinations or unavailability, or priority determinations by the US Government under the Defense Priorities and Allocations System (15 CFR Part 700).

"Form of FAA Cross-Waiver" means as found in Appendix B to 14 CFR Part 440 at the following hyperlink: http://www.ecfr.gov/cgi-bin/text-idx?rgn=div5&node=14:4.0.2.9.22#14:4.0.2.9.22.1.30.12.33. In the event this link is ever deactivated, the Form of Cross Waiver will be the most recent Form of Cross-Waiver published in the US Code of Federal Regulations.

"Intentional Ignition" means when the ignition command is given for purposes of Payload carriage causing ignition of the first-stage engines of the Launch Vehicle.

"Interface Control Document (ICD)" means that document which will be prepared by SpaceX with data to be supplied by Customer, negotiated in good faith and mutually agreed upon in writing by both Parties prior to the beginning of the Launch Period. The Interface Control Document will supersede any interface requirements document.

"ITAR" means the International Traffic in Arms Regulations administered by the Directorate of Defense Trade Controls, U.S. Department of State, 22 C.F.R. Parts 120-130, pursuant to the Arms Export Control Act of 1976, as amended, 22 U.S.C. § 2778.

"Launch" means Intentional Ignition followed by either: (a) Lift-Off or (b) the loss or destruction of the Payload or the Launch Vehicle (or both).

"Launch Campaign" means the activities and discussions leading up to and including Payload to Launch Vehicle integration at the Launch Site through Launch.

"Launch Complex" means the SpaceX-operated facility where the Launch Vehicle is integrated and from which the Launch Vehicle is launched.

"Launch Date" has the meaning set forth in Section 6.6.1. If the Launch Date has not yet been established in accordance with Section 6.6.1, the Launch Date will be deemed the first day of the Launch Period.

"Launch Period" has the meaning set forth in the Agreement.

"Launch Range" means the U.S. Governmental authorities and office with jurisdiction over the Launch Site.

"Launch Services" means those services described in this document to be performed by SpaceX.

"Launch Site" means the SpaceX launch facility at Cape Canaveral Air Force Station or another SpaceX launch facility capable of supporting the Launch Services, as determined by SpaceX.

"Launch Vehicle" means a launch vehicle capable of achieving Customer's orbital parameter requirements as set forth in the Agreement, and refers to the Falcon 9 Launch Vehicle in this document.

"Launch Window" means the time period established by SpaceX during which the Launch is scheduled to occur on the Launch Date.

"Licenses" means all licenses, authorizations, clearances, approvals and permits necessary for each Party to carry out its respective obligations under the Agreement. Each Party agrees to provide reasonable assistance to the other Party as necessary to obtain such Licenses.

"Lift-Off" means release of the hold-down restraints and physical separation of the Launch Vehicle from the launch pad.

"Material Breach" means a breach in which the non-breaching party did not receive the "substantial benefit" of the bargain under the Agreement. To exercise its right to terminate for Material Breach, Customer shall notify SpaceX of this election to terminate in writing and within thirty (30) days following the conclusion of the ninety (90) day cure period. For the sake of clarity, neither (i) a delay nor ii) a Launch or Launch Activities resulting in the loss or destruction of the Payload, shall be deemed a Material Breach by SpaceX hereunder, and except as expressly stated in the Termination section of the Terms and Conditions, nothing in this Agreement shall be construed in any way as obligating SpaceX to refund any payment made in connection with any Launch Services performed hereunder.

"Mechanical Interface Ring" means the SpaceX provided structural interface utilized to mechanically mate the Payload to the Launch Vehicle hardware.

"Mission" means the services and deliverables to be provided by both SpaceX and Customer to perform a Launch of the Payload, with an initial Launch-ready mass and orbit parameters defined in the Agreement.

"Parties" means Customer and SpaceX.

"Party" means Customer or SpaceX.

"Payload" means the Customer provided integrated spacecraft, dispensers, separation systems, harnessing, and avionics to be launched in accordance with the parameters set forth in the Acceptance of Request. The Payload may not contain any Payload Constituents provided by the Customer without the written mutual agreement of SpaceX.

"Payload Constituent" means (a) spacecraft, payload, instrument, experiment, or similar equipment that is integrated onto or into the Payload, but is not an integral part of the Payload, including but not limited to CubeSats, small satellites, and hosted payloads; and (b) any integrated dispenser, separation system, or other significant hardware that are contained within the Payload.

"Primary Payload" means a satellite independently contracted with SpaceX that does not meet the definition of a Rideshare Payload as defined in this document.

"Registration Convention" shall mean the Convention on Registration of Objects Launched into Outer Space, done Nov. 12, 1974 (opened for signatures Jan. 14, 1975), 28 U.S.T. 695, T.I.A.S. No. 8480, 1023 U.N.T.S. 15.

"Related Third Parties" means (a) the Parties' and Co-Payload Customer(s)' respective contractors and subcontractors involved in the performance of this Agreement and their respective directors, officers, employees, and agents; (b) the Parties' and Co-Payload Customer(s)' respective directors, officers, employees, and agents; and (c) any entity or person with any financial, property or other material interest in the Payload, Co-Payload(s), the Launch Vehicle or the GSE.

"Secondary Rideshare" means Rideshare Payloads that are paired on the same mission as a Primary Payload.

"SpaceX Account" means the account to which Customer shall make payments to SpaceX, as notified by SpaceX from time to time, within a reasonable time to make such payments.

"Standard Offering Bulkhead" means the Launch Vehicle side electrical interface Customer built Payload harnessing will connect to consisting of two separation signal connectors and one umbilical connector.

"Starlink" means the satellite constellation operated by SpaceX and launched onboard SpaceX Launch Vehicles.

"Terminated Ignition" means Intentional Ignition not followed by Launch.

