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**Space Launch
Sample Mission 3.2**

**Mission Requirements Document (MRD)
F0XXXXXX
D.O. SM-3.2**

Basic

18 May 2011

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1.0 INTRODUCTION

1.1 OVERVIEW

This document provides the requirements for Sample Mission 3.2 (SM-3.2) to be conducted under the Orbital Suborbital Program -3 (OSP-3) contract.

The SM-3.2 is a space mission being sponsored by the Space Test Program (STP). The US Air Force, Space and Missile System Center (SMC) Rocket Systems Launch Program (RSLP) office, Space Development and Test Directorate (SDTD)/Launch Systems Division (SDL), will provide the Launch Vehicle (LV) and launch services for this mission through the OSP-3 contract. The DoD Space Test Program (STP) will be responsible for coordination of all payload activities.

The baseline launch location for this mission will be from Cape Canaveral Air Force Station.

The Initial Launch Capability (ILC) is Q3 of 2014.

This will be an OSP-3 Category 3 mission, EELV New Entrant candidate.

1.2 SCOPE

The purpose of this document is to serve as the controlling source and authority for the SM-3.2 mission requirements. In addition to specifying mission requirements, this MRD will:

- a) Identify roles, responsibilities and interfaces among the various contractors and Government agencies supporting the mission.
- b) Document data to be provided by the agency furnishing the payloads to be used by the LV Contractor (LVC) in developing the LV configuration, payload separation system(s), targeting the LV, processing the flight hardware, and conducting the mission.
- c) Identify constraints and environments the SV must meet.
- d) Identify test and analysis requirements to verify interfaces between the payloads and LV and to verify required payload characteristics.

- e) Define mission specific work required of the LVC and mission enhancement(s) to be priced separately.

This MRD will be maintained by SMC/SDL. In many cases, the detailed requirements and data will be specified in other documentation, which will be referenced herein. This includes documents such as the OSP-3 Statement of Work, OSP-3 Technical Requirements Document and the EELV Standard Interface Specification.

In the case of conflict between this document and any document referenced herein, this document shall take precedence.

1.3 MISSION OBJECTIVES

The primary goal of the SM-3.2 mission is to launch an experimental satellite referred to as the Primary space vehicle (SV) and insert it in geosynchronous orbit (GSO) at an inclination of 0°. The secondary goals of the mission are to: launch a propulsive EELV Secondary Payload Adaptor (ESPA) ring loaded with five Auxiliary Payloads (APLs) and deploy it into a LEO orbit; and launch a fixed ESPA ring with up to six (6) APLs, four (4) of which will be deployed in a LEO orbit and the remaining two (2) to be deployed in the Primary SV orbit. This will demonstrate the capability to successfully deploy APLs prior to the deployment of a primary payload without degrading the primary payload mission. The LV contractor (LVC) will provide a dual payload adaptor fitting (DPAF) to encapsulate the Primary SV and support the propulsive ESPA during launch. APLs will be in an inert state during the launch.

Specific objectives for the boost and insertion portion of the mission are as follows:

Insertion Orbit #1: Safely deliver the integrated payload stack to a 550 km circular orbit at an inclination of 45 degrees. Deploy the propulsive ESPA loaded with five (5) APLs and then deploy four (4) APLs from the non-separating ESPA ring. Depending on mission analysis, the upper half of the DPAF may also get deployed in this orbit prior to the LV moving to the second mission orbit.

Insertion Orbit #2: Safely deliver the Primary SV and fixed ESPA ring containing two (2) APLs to an orbit of 36,086 +/- 50 km (~GEO + 300 km) at an inclination of zero degrees (0°).

1.4 ROLES AND RESPONSIBILITIES

The interfaces among agencies and contractors that will support the SM-3.2 mission are shown in Figure 1.1. Their roles and responsibilities are described below:

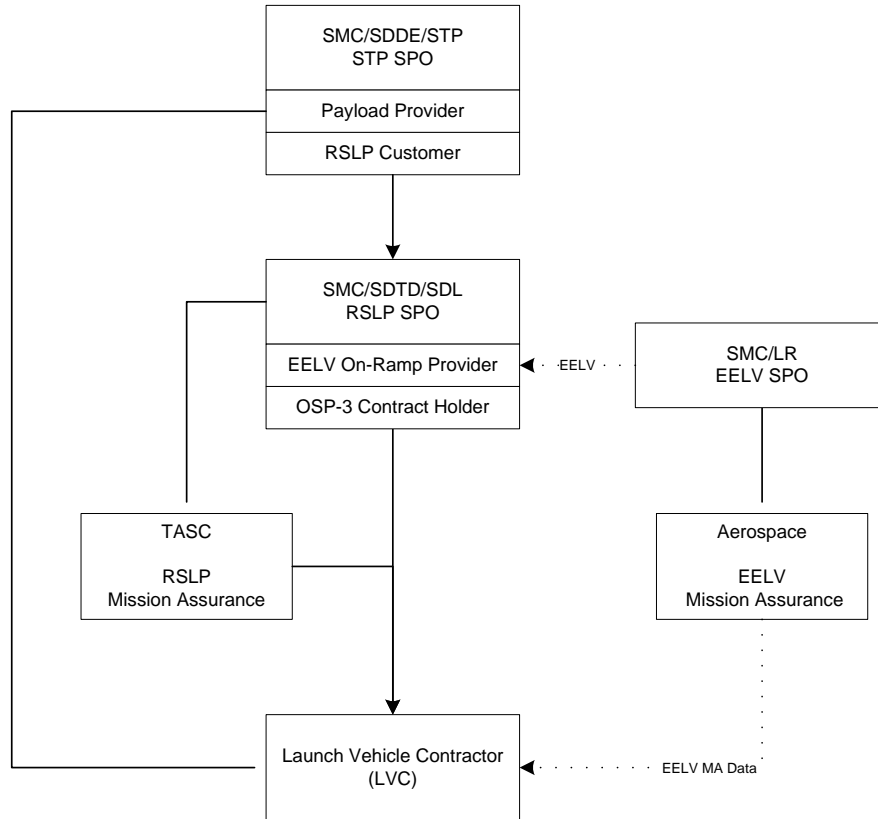


Figure 1.1 – SM-3.2 Interfaces among Agencies and Contractors

STP: Provider of both primary and secondary payloads and customer of the RSLP. The STP is responsible for selecting and supplying the payload as well as ensuring their space worthiness. STP will also provide support for joint LV/SV integration procedures. Additionally, the STP will provide submissions for the LVC’s Range Safety documentation at the request of RSLP.

SMC/SDL: SDL is located at Kirtland AFB, NM. SDL is the agency in charge of the Rocket System Launch Program. SDL provides for launch services to the DoD; these services include range support, LV integration, and payload interface and mating. SDL fulfills these responsibilities, in part, through procuring the services of a LVC under the OSP-3 contract. In addition SMC/SDL will facilitate new entry opportunities into the EELV program by providing potential new entrants with opportunities to demonstrate their ability to conduct EELV-type missions.

TASC: Systems Engineering and Technical Advisor to SMC/SDL. TASC provides Mission Assurance (MA) and Independent Verification and Validation (IV&V) support to the RSLP program. This may take the form of on-site oversight of the LVC or analysis of data and other work products provided by the LVC. Higher level risks identified by TASC will be communicated to the SDL Mission Manager. This information will also be used to support overall risk assessments of the program which will be addressed in regular team meetings, design reviews and readiness reviews.

SMC/LR: LR is located at Los Angeles AFB, CA. LR is the agency in charge of the Evolved Expendable Launch Vehicle (EELV) program. This mission has been identified as a potential New Entrant opportunity for this program. LR will have access to all data and deliverables collected during this mission for the purpose of evaluating the LVC's readiness to proceed to later stages of the EELV qualification process.

Aerospace: This Federally Funded Research & Development Corporation (FFRDC) acts as a Technical Advisor to SMC/LR. Aerospace provides Mission Assurance (MA) support to the EELV program as well as MA and other support to STP and RSLP. Aerospace may observe any activities and evaluate any information gathered by the RSLP for this mission. Aerospace personnel may participate in any MA or other mission related activity on a non-interference basis.

LVC: SMC/SDL will contract with the LVC to provide the LV design, equipment, integration, payload interface, payload deployment system(s), vehicle mating, mission planning, launch of the vehicle and post flight reports and analysis.

2.0 LAUNCH SYSTEM REQUIREMENTS

2.1 LAUNCH VEHICLE CONFIGURATION

The LV system configuration shall meet the requirements detailed in the OSP-3 TRD.

The LVC shall provide an interface adapter between their LV and a standard ESPA ring. The top of this interface adapter will be used by LVC and others as the LV/payload interface plane.

The enhancements to the OSP-3 standard requirements for this mission are:

- A-1 Separation System
- A-2 Conditioned Air
- A-4 Access Panel
- A-5 Enhanced Telemetry
- A-8c Alternate Launch Location (CCAFS)
- A-12 Orbital Debris Mitigation System

2.2 ENVIRONMENTS

The LV shall provide a boost environment that does not exceed the levels defined in the EELV-SIS. Specific environments will be defined in the LV/SV ICD.

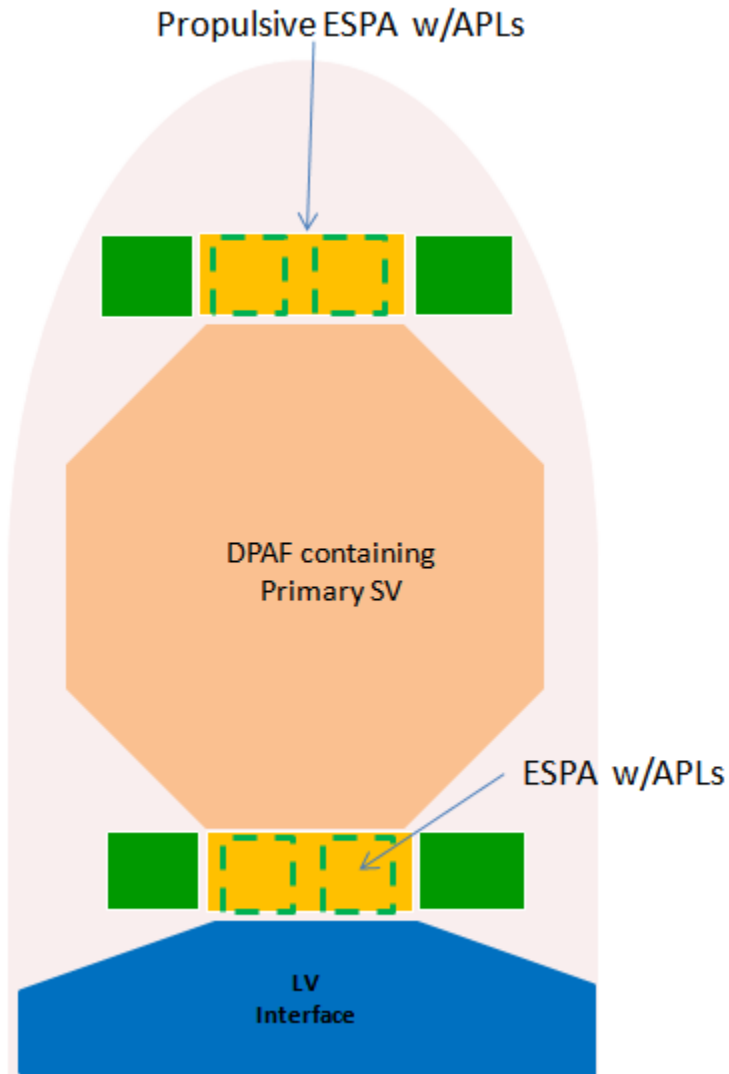
2.3 TELEMETRY

Telemeter navigation, attitude, and environments to verify mission requirements and post flight evaluation through all mission events.

3.0 SPACE VEHICLE (SV) REQUIREMENTS

3.1 SPACE VEHICLE CONFIGURATION

The image below represents the notional configuration of the integrated payload stack. Final configuration will be determined by the LVC to meet mission requirements and accommodate specific launch vehicle configuration capabilities and limitations.



3.1.1 Primary SV Configuration

Primary SV Envelope (on-orbit deployed configuration)

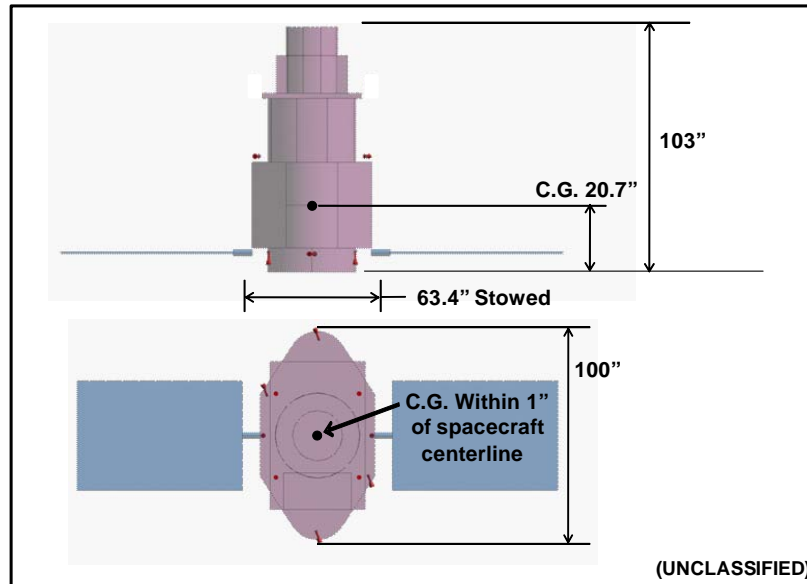


Figure 3.1: SM-3.2 Primary SV Static Envelope

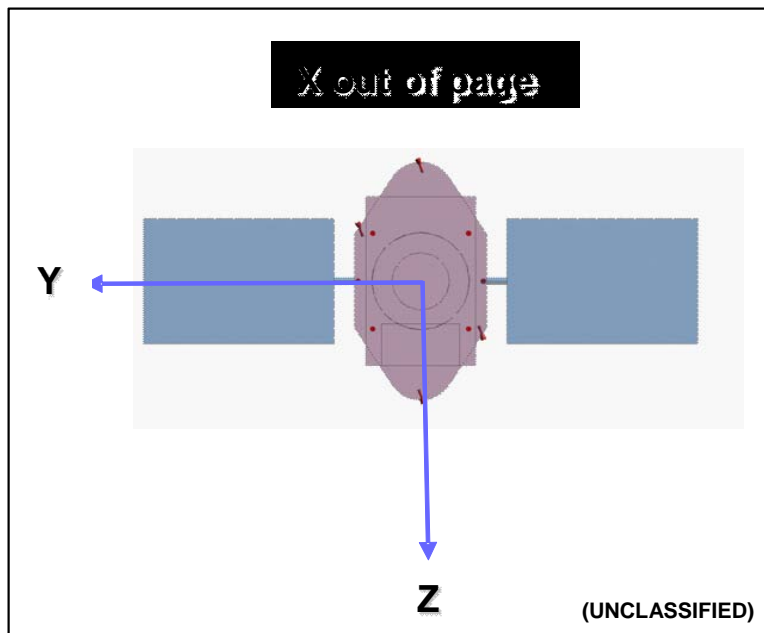


Figure 3.2: Primary SV Mass Properties Coordinate System

SV Coordinate System: The Primary SV coordinate system is a right-handed, orthogonal coordinate system as shown in Figure 3.2. The origin of the coordinate system is located in the launch vehicle adapter separation plane and at the center of the spacecraft. The X-axis is along the longitudinal axis of the spacecraft with +X pointed forward. The Y-axis aligns with the centerline of the solar panel axis with the +Y pointed towards the avionics deck nearest the battery. The Z-axis completes a right

handed, orthogonal system. Roll is defined about the +X-axis. Pitch is defined about the +Y-axis. Yaw is defined about the +Z-axis.

Interface: The structural interfaces between the SV and the LV include the interfaces at the launch vehicle adapter, the payload fairing, and electrical connections through the LVA. The launch vehicle adapter (LVA) shall include a low-shock Marmon clampband separation system. The SV side of the interface to the LVA is a 37-inch diameter titanium interface ring.

SV Access Requirements: After encapsulation, the LVC shall provide provisions to access to the primary SV items listed below. Fairing access door sizes and locations are TBD.

- 1) Accessible door for propulsion fill and drain access
- 2) Test connector/safe and arm panel access door
- 3) Battery enable plug
- 4) Spacecraft safe/enable plugs

Solar Arrays: Define solar array volume TBD

Primary SV Battery Charge Power

The SV contains one 66-amp hour Li-Ion battery comprised of one ABSL 8s44p Li-Ion battery module. The LVC shall connect the battery to the SV main bus via battery enable plugs. The LVC shall provide battery charging during ground processing via a GSE external charging source through the battery enable plug interface with the SV powered on. This EGSE uses battery temperature and voltage parameters to control the charge rate.

Primary SV Telemetry Interface

The LV shall provide one telemetry channel capable of receiving up to 2 kbps of data for retransmission of Primary SV real time telemetry to the ground. The telemetry channel shall consist of two RS-422 differential line receivers, one for Non-return-to-Zero Level (NRZ-L) coded data and one for the clock. The LVC shall present data as the original NRZ-L data stream in real time for those portions of prelaunch operations and flight. The LVC shall record SV data to digital media for post flight analysis.

Primary SV Power During Launch

The LV shall provide power to the SV during ascent (TBR).

Ground Support Equipment: Electrical interfaces include the SV to LV flight electrical interfaces, the Electrical Ground Support Equipment (EGSE) interfaces, and telemetry/command links.

The LSC shall provide SV umbilical link between the SV and the SV EGSE located in the SV control room from the time of SV mate until launch.

Ordnance and Hazardous Materials: The launch vehicle adapter (LVA) shall include a low-shock Marmon clampband separation system. The primary SV will have hazardous materials as defined in the propulsion system below.

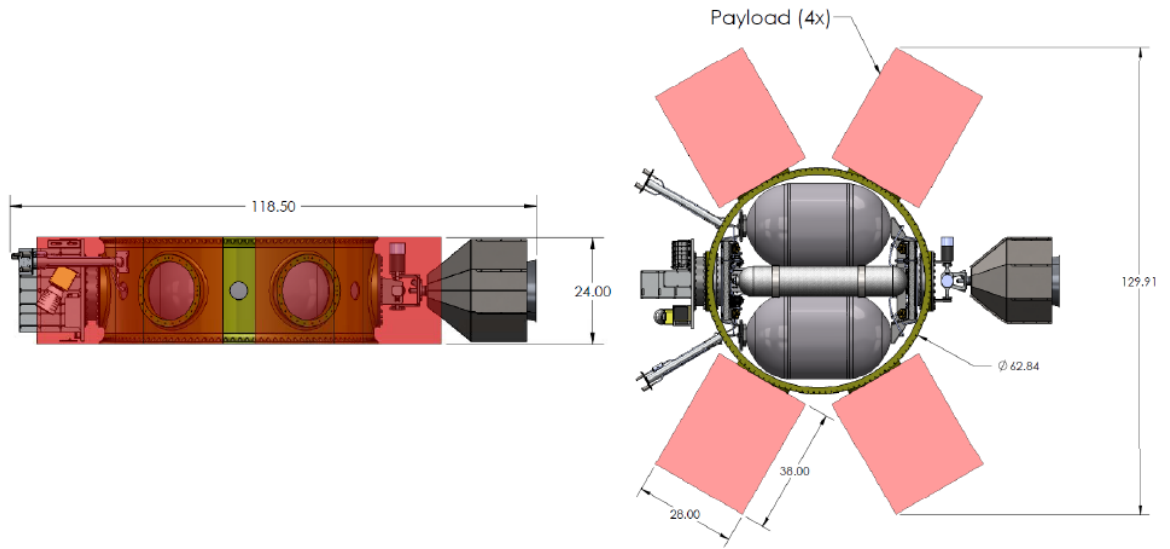
Propulsion System: There are two identical nested dome fuel/oxidizer tanks on the SV, each containing hydrazine (N_2H_4) and 3% Mixed Oxides of Nitrogen (MON-3). The fuel/oxidizer tank material of construction is 6AL-4V STA Titanium. There are also two identical pressurant gas tanks containing gaseous Helium (GHe). The pressurant tanks are Composite Overwrapped Pressure Vessels (COPV) of Graphite-Epoxy with an Inconel 718 liner. The mass fraction of propellant to total SV mass is approximately 20%. The configuration of the SV propellant tanks shall be as shown in Table 3.1 Primary SV Propellant System.

SV Tank	Propellant Type	Fill Fraction min/max (percent)	Propellant Density @70 deg F (gm/cm ²)	Shape	Interior Dimensions	Damping Coefficient (percent)	X (in)	Y (in)	Z (in)
Tank #1	Fuel: N ₂ H ₄	min: 90 max: 95	TBD	Nested Dome Hemisphere Capped Cylinder	VF: 5380 in ³ VO: 3320 in ³	TBD	TBD	TBD	TBD
	Oxidizer: MON-3	min: 90 max: 95	TBD		ID: 21.25 in L: 31 in				
Tank #2	Fuel: N ₂ H ₄	min: 90 max: 95	TBD	Nested Dome Hemisphere Capped Cylinder	VF: 5380 in ³ VO: 3320 in ³	TBD	TBD	TBD	TBD
	Oxidizer: MON-3	min: 90 max: 95	TBD		ID: 21.25 in L: 31 in				
Tank #3	Pressurant: Helium	N/A	TBD	Cylindrical	V: 500 in ³ ID: 6.6 in L: 22.3 in	TBD	TBD	TBD	TBD
Tank #4	Pressurant: Helium	N/A	TBD	Cylindrical	V: 500 in ³ ID: 6.6 in L: 22.3 in	TBD	TBD	TBD	TBD

Table 3.1 Primary SV Propellant System

3.1.2 Propulsive ESPA Configuration

This is a representation of a specific Propulsive ESPA design which includes four (4) APLs. While the design details (including the number of APLs accommodated) differ for other Propulsive ESPAs; the basic size and configuration (i.e. ESPA ring used as primary structure, 24” height, diameter (including attached APLs) of 138”) will be common to all the Propulsive ESPAs considered for this mission. Final selection of the Propulsive ESPA for this mission will be made by L-24 mo.



Note: all dimensions in inches

3.1.3 ESPA Ring and APLs Configuration

Fig 3.1.3a is a representation of the standard ESPA design which includes six (6) APLs. APLs will meet the requirements defined in the ESPA Rideshare Users Guide [Ref 5] unless specific exceptions are approved by the USG and LVC. Final selection of the APLs for this mission will be made by L-24 mo.

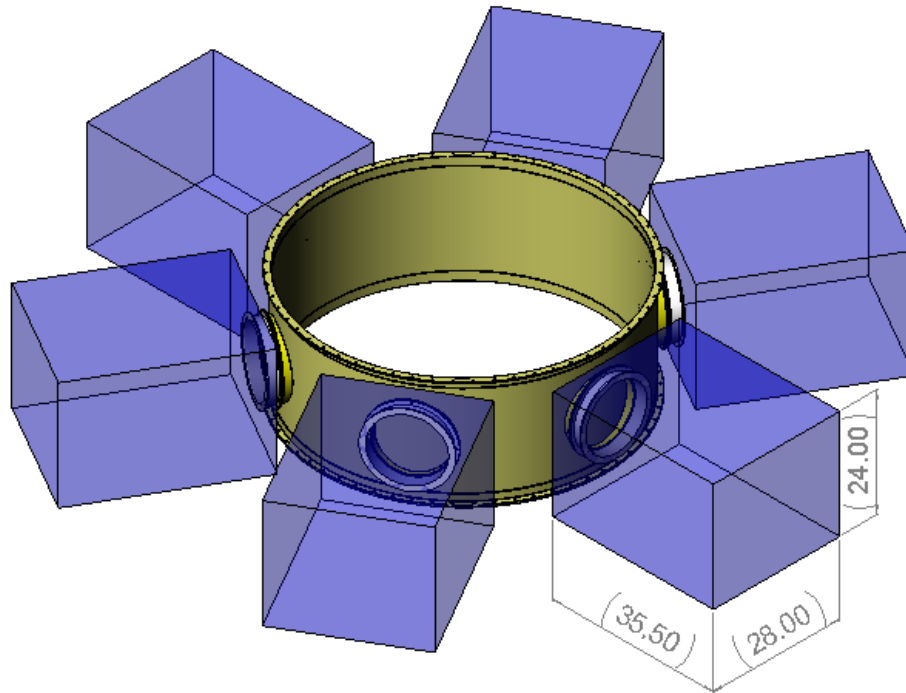


Fig 3.1.3a

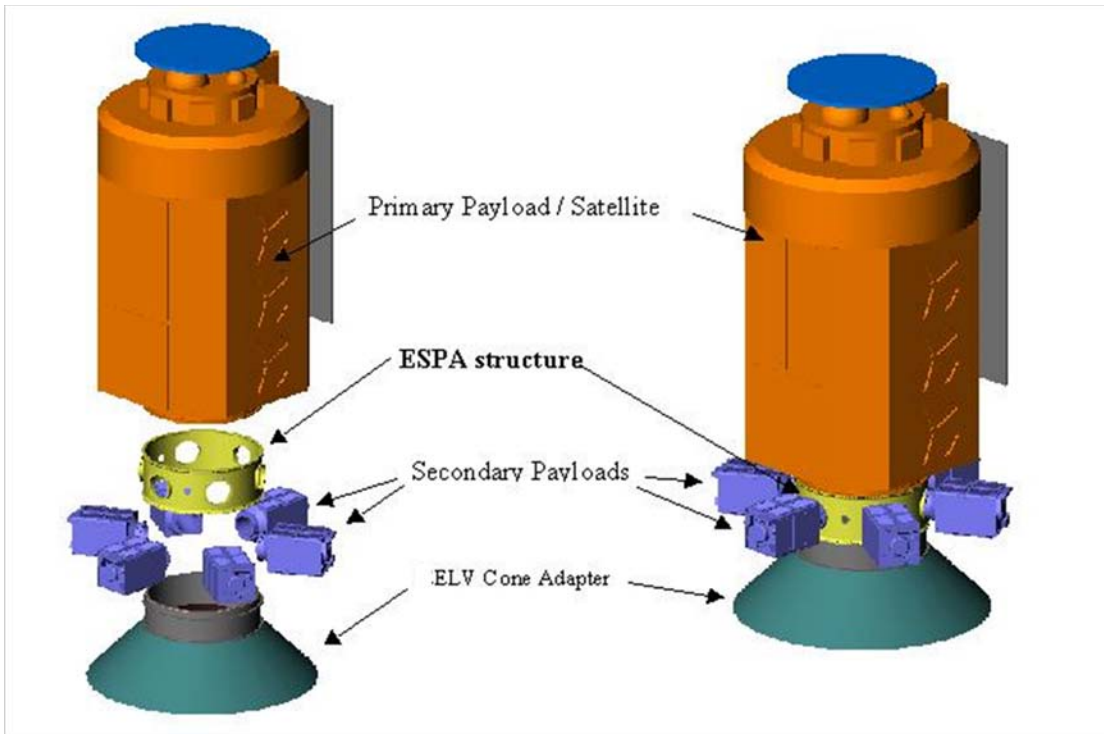


Fig 3.1.3b

Fig 3.1.3b is a representation of a standard ESPA incorporated into a notional payload stack. *Note: Propulsive ESPA not shown in depiction above.*

3.2 MASS PROPERTIES

3.2.1 Primary SV Mass Properties (including propellant)

MASS (LB _M)	3306.94 *
XCG (IN)	20.73 “
YCG (IN)	0.130 “
ZCG (IN)	0.358”
IXX (LB _M -IN ²)	1,540,474.486
IYY(LB _M -IN ²)	2,916,326.38
IZZ (LB _M -IN ²)	2,088,053.48
IXY (LB _M -IN ²)	-748.304
IYZ(LB _M -IN ²)	81,336.375
IXZ (LB _M -IN ²)	-30,855.109

(The mass properties coordinate system shown in figure 3.2)

***Note: The Primary SV mass is projecting to grow to 3748 lbs.**

3.2.2 Propulsive ESPA Mass Properties (including propellant)

MASS (LB _M)	4078.56*
XCG (IN)	0.453” TBR
YCG (IN)	0.173” TBR
ZCG (IN)	-0.094” TBR
IXX (LB _M -IN ²)	TBD
IYY(LB _M -IN ²)	TBD
IZZ (LB _M -IN ²)	TBD
IXY (LB _M -IN ²)	TBD
IYZ(LB _M -IN ²)	TBD
IXZ (LB _M -IN ²)	TBD

* Note: Propulsive ESPA and integrated APL weight 1850kg.

3.2.3 ESPA Ring and APLs

MASS (LB _M)	2695 *
XCG (IN)	TBD
YCG (IN)	TBD
ZCG (IN)	TBD
IXX (LB _M -IN ²)	TBD
IYY(LB _M -IN ²)	TBD
IZZ (LB _M -IN ²)	TBD
IXY (LB _M -IN ²)	TBD
IYZ(LB _M -IN ²)	TBD
IXZ (LB _M -IN ²)	TBD

** Note: The mass identified represents the estimated maximum mass of the integrated ESPA Ring and six (6) APLs [at maximum mass for each APL per ESPA RUG is 400lbs not including the separation system]. Estimated mass includes APL separation systems but does not include any required LV to ESPA interface hardware (i.e. interface rings or LV adapter cones) or ESPA harnessing which must be developed and supplied by the LVC.*

The basic ESPA Ring structure weighs 295 lbs. ESPA APL mass properties will meet ESPA RUG requirements [Ref 5] unless specific exceptions are approved by the USG and LVC.

3.3 SPACE VEHICLE ENVIRONMENTS AND STRUCTURAL CHARACTERISTICS

All payloads, when integrated with the separation system, shall have a first modal frequency as detailed in the LV/PL ICD. An initial Finite Element Model (FEM) of the payloads shall be provided to the LVC for use in the Coupled Loads analysis (CLA). The FEM will be test-verified to ensure the FEM used for the CLA is accurate.

3.4 PAYLOAD ELECTRICAL INTERFACES**3.4.1 Payload Separation Signals**

The Primary payload and APL separation systems will be actuated by primary and redundant commands from the LV. The LV shall detect a positive indication of separation and include a separation confirmation in the LV telemetry data, through a minimum of two loopbacks.

3.4.2 Communication Interfaces

The payloads will not require communication with the LV. The LV will provide pass through circuits for payload communication with GSE.

3.4.3 RF Sources

The LV and the payloads shall include the RF sources and receivers identified in Table 3-2. The payload transmitters shall not be turned on prior to separation from the LV. The LVC will verify compatibility of the selected frequencies for any pre-launch periods in which simultaneous operation is present or implement procedures so that no simultaneous operations occur. APLs will meet RF sources requirements as defined in the ESPA RUG [Ref 5].

SOURCE	FREQUENCY (MHz)
LV	
Telemetry Transmitter	
C-Band Radar Transponder	
Transmit	
Receive	
GPS Transmitter	
Command/Destruct Receiver	
PAYLOAD	
Prime SV SGLS Receiver	TBD
Prime SV SGLS Transmitter	TBD
Propulsive ESPA SGLS Receiver	TBD
Propulsive ESPA Transmitter	TBD
APL 1 C&DH Receiver	TBD
APL 1 Transmitter	TBD
APL 2 C&DH Receiver	TBD
APL 2 Transmitter	TBD
APL 3 C&DH Receiver	TBD
APL 3 Transmitter	TBD
APL 4 C&DH Receiver	TBD
APL 4 Transmitter	TBD
APL 5 C&DH Receiver	TBD
APL 5 Transmitter	TBD
APL 6 C&DH Receiver	TBD
APL 6 Transmitter	TBD
APL 7 C&DH Receiver	TBD
APL 7 Transmitter	TBD
APL 8 C&DH Receiver	TBD

APL 8 Transmitter	TBD
APL 9 C&DH Receiver	TBD
APL 9 Transmitter	TBD
APL 10 C&DH Receiver	TBD
APL 10 Transmitter	

Table 3-2. RF Sources

3.4.4 Ground Power

The launch system shall provide pass through for the payload Electrical Ground Support Equipment (EGSE). EGSE provides power to the payloads through circuits to be defined in the LV/SV ICD

3.4.5 Command, Control, and Monitor

The launch system shall provide 200 ground umbilical circuits to the payloads until launch (TBD). The ground umbilical circuits shall include at least six pairs of twisted shielded cable that is suitable for RS-422 serial communications, in addition to the power requirement in 3.4.4. The umbilical shall provide the capability to remotely control and monitor the payloads and charge batteries using GSE furnished by the SV contractor.

LV Interface to Primary SV: The LVC shall provide the Primary SV to LV electrical interconnection from the time of Primary SV mate until SV separation from the launch vehicle. The LV shall provide the following Flight Electrical Interfaces:

- a. The SV will require one main electrical umbilical (LVI J1), with a 61-pin connector.
- b. SV to LV Interface Connector Pin Assignments - The SV umbilical interface connector shall have the pin number assignments as shown in Table 3.2.

Umbilical J1		Umbilical Wire Types		Umbilical J1		Umbilical Wire Types	
Pin Number	Signal Name	Power	Data or Monitor	Pin Number	Signal Name	Power	Data or Monitor
1	Uplink Clock In HI		1	25	Battery Voltage Sense HI		1
2	Uplink Clock In LO		1	26	Battery Voltage Sense LO		1
3	Uplink Data In HI		1	27	Battery Voltage Sense HI		1
4	Uplink Data In LO		1	28	Battery Voltage Sense LO		1
5	Uplink Data Good HI		1	29	Battery Temp Sense HI		1
6	Uplink Data Good LO		1	30	Battery Temp Sense LO		1
7	Downlink Clock Out HI		1	31	Battery Temp Sense HI		1
8	Downlink Clock Out LO		1	32	Battery Temp Sense LO		1
9	Downlink Data Out HI		1	33	Bus Temp Sense HI		1
10	Downlink Data Out LO		1	34	Bus Temp Sense LO		1
11	SV Sep Detect 1		1	35	Bus Temp Sense HI		1
12	SV Sep Detect 1 RTN		1	36	Bus Temp Sense LO		1
13	SV Sep Detect 2		1	37	+28V T-0 Power 1	1	
14	SV Sep Detect 2 RTN		1	38	+28V T-0 Power 1 RTN	1	
15	SV Sep Detect 3		1	39	+28V T-0 Power 2	1	
16	SV Sep Detect 3 RTN		1	40	+28V T-0 Power 2 RTN	1	
17	LV Sep Detect 1		1	41	+28V T-0 Power 3	1	
18	LV Sep Detect 1 RTN		1	42	+28V T-0 Power 3 RTN	1	
19	LV Sep Detect 2		1	43	+28V T-0 Power 4	1	
20	LV Sep Detect 2 RTN		1	44	+28V T-0 Power 4 RTN	1	
21	InhibitArm A1		1	45	+28V T-0 Power 5	1	
22	InhibitArm A2		1	46	+28V T-0 Power 5 RTN	1	
23	InhibitFire A1		1	47	+28V T-0 Power 6	1	
24	InhibitFire A2		1	48	+28V T-0 Power 6 RTN	1	

Table 3.2 Primary SV Umbilical Requirements

LV Interface to Propulsive ESPA: The LVC shall provide the LV to Propulsive ESPA electrical interconnection from the time of Propulsive ESPA mate until SV separation from the launch vehicle. The LV shall provide the following Flight Electrical Interfaces as identified 48 twisted shielded pairs (TBR).

LV Interface to ESPA Ring APLs: The LVC shall provide a LV to ESPA Ring APLs electrical interconnection that meets, at a minimum, the APL interface defined in the ESPA RUG [Ref 5].

3.4.6 Space Vehicle Initialization Signal Sequence

The SM-3.2 SV shall require four primary and four redundant 26V - 34V, 5amp to 12amp initialization signals. Each signal shall be 0.05 sec in duration. The first pair of primary initialization signals will be commanded 2 seconds after the LV completes maneuvers to the required separation attitude, defined in section 5.4, redundant initialization signals will be commanded 0.25 seconds after the primary signals. The second pair of primary initialization signals will be commanded 30 seconds after the first pair of redundant initialization signals followed by redundant initialization signals commanded 0.25 seconds after the second pair of primary signals. TBR

3.5 THERMAL ENVIRONMENT

Thermal environment and relative humidity conditioning must be provided to the SV at all times prior to launch except during transport to West Coast Spaceport and during the Upper Stack Emplacement, subsequent to further analysis and understanding of the thermal environments during transport and emplacement by the SV customer.

Primary SV Thermal Requirements - The Primary SV will drive the payload stack thermal requirements.

SV Heat Dissipation – The LVC will launch the space vehicle in a minimum power state. The SV heat dissipated from payload encapsulation to launch shall be less than 60 watts (TBR).

Pre-Flight Thermal Environment - The prelaunch ambient air temperatures internal to the payload fairing shall be 43 to 85 deg F (6 to 29 deg C).

Flight Thermal Environment – The LVC shall ensure the internal payload fairing temperature and emissivity do not exceed the values shown in??

Propulsive ESPA and ESPA Ring APLs: The Propulsive ESPA and ESPA Ring APLs will be compatible with the thermal environments defined in the ESPA RUG [Ref 5]. The LV shall provide a thermal environment to the APLs that does not exceed the APL design requirements specified in the ESPA RUG [Ref 5].

3.6 CONTAMINATION

The LVC shall maintain payloads in a CLASS 10,000 environment to ensure that level 400 surface quality maintained with no condensation forming on surfaces. The LVC shall clean inner surfaces of the fairing and deck to this standard prior to payload encapsulation. (TBR)

Primary SV: From the beginning of Primary SV encapsulation and through Contamination Collision Avoidance Maneuver (C/CAM), the molecular contamination induced by the LV on SV surfaces shall be less than 150 angstroms. (TBR)

Propulsive ESPA and ESPA Ring APLs: The Propulsive ESPA and ESPA Ring APLs will be compatible with the contamination requirements defined in the ESPA RUG [Ref 5].

3.7 EMI / EMC

The LVC shall establish maximum radiated and conducted emission levels that the LV might generate. These levels will be documented in the LV/PL ICD. The payload will incorporate these criteria as well as environments from the applicable launch site (radars,

etc) in their design requirements. The LVC shall also establish maximum levels the payloads can conduct or radiate while mated to the LV. In general, the payloads shall not radiate any time after encapsulation in the fairing and until a defined time after separation from the LV after orbital insertion. Any required deviations to this requirement shall be coordinated with the LVC and documented in the LV/PL ICD. The payload provider shall ensure these requirements are met through good design practices and analysis.

Propulsive ESPA and ESPA Ring APLs: The Propulsive ESPA and ESPA Ring APLs will be compatible with the EMI/EMC requirements defined in the ESPA RUG [Ref 5] .

3.8 SAFETY DOCUMENTATION

RSLP will provide system safety documentation (including range approved SV related safety documentation) to the LVC for attachment to the LVC safety documentation, as required. The LVC shall submit all system safety documentation for range approval in accordance with AFSPCMAN 91-710 requirements. The LVC shall ensure hazards have been adequately addressed at the system level. Documentation from the payload provider regarding the payload(s) will include as a minimum:

- a. Preliminary Hazards Analysis identifying potential hazards and plans for mitigating them.
- b. A System Hazards Analysis Report (SHAR) or equivalent documentation demonstrating that all hazards are identified and controlled in compliance with AFSPCMAN 91-710 and RCC 319-99.
- c. All other interfaces (e.g. telemetry, flight safety, ground safety, CONOPS, etc) shall be documented in the UDS documentation.

4.0 VERIFICATION REQUIREMENTS

Verification testing shall be conducted to verify the compatibility of hardware supplied by different contractors/government agencies and to verify certain SV/LV integration characteristics. Analyses may be used in place of testing upon approval by SMC/SDL.

LV top-level test requirements are defined in the following paragraphs. Detailed test requirements will be documented by the LVC as part of the Integrated Test Plan. These requirements will be coordinated with the participating agencies and approved by SDL. The test procedures shall be submitted 30 days prior to testing, for review, to ensure compliance with the approved test requirements.

4.1 DESIGN VERIFICATION TESTS

Design verification tests are conducted to establish confidence in compatibility between two or more contractors' hardware. The test conductor shall prepare a test report summarizing the test set up, the results, and any anomalies.

4.1.1 Integrated Mechanical / Structural Analysis and Verification Tests

A series of mechanical/structural tests shall be conducted at the LVC facilities. The LVC shall conduct the testing with the greatest level of customer participation possible. The LVC and payload provider will provide flight representative hardware to support conduct of the testing.

4.1.1.1 Launch Vehicle / Payload Mechanical Interface Verification

A mechanical fit check shall be performed to verify LV to payload mechanical compatibility. This will include cable routing and connections and any areas where there are potential interference issues. The LVC and the payload provider will provide flight representative hardware to support the fit checks. The fit checks will be performed at the LVC facilities or at a location best determined to meet the compatibility requirements.

4.1.1.2 Launch Vehicle / Payload Coupled Loads Derivation

The LVC shall perform coupled loads assessments (CLA) to predict the maximum loads that can be expected by the payloads during the space lift events. The CLA will address key loading events including lift-off, maximum dynamic pressure, transonic, staging/ignition events and will include steady state conditions. Preliminary CLAs will be performed using preliminary SV provided models to support SV design and test programs and delivered within four (4) months of task order award. A final verification loads cycle will be performed with test verified models no later than L minus six (6) months.

4.1.1.3 Space Vehicle Structural Integrity Test

The payload provider will verify that integrated loads derived through the CLA, described in Paragraph 4.1.1.2, are acceptable for their payload or otherwise design the necessary modifications to meet those loads. The primary SV and Propulsive ESPA system are designing to meet the environments imparted by the EELV system. The APLs are building to meet the environments specified in the ESPA RUG [Ref 5].

The payload provider will be responsible for all structural tests required on the payload side of the interface to verify this requirement. The required tests will be conducted by the payload provider using flight representative hardware and will require a loads profile from the LVC, in order to conduct the analysis and run the test. Also, it is desirable for the payload provider to have access to the separation system during the test.

4.1.1.4 Modal Survey

Finite Element models of the LV and the payloads are required for flight analysis. The payload provider will provide a preliminary payload math model for initial flight analysis. A test verified payload math model will be provided for the final flight analysis and final load cycle analysis. A modal survey (preferred) or other SV approved method is required.

4.1.2 Electrical Verification Tests

4.1.2.1 Aerospace Vehicle Equipment (AVE) Electrical Verification

Testing shall be conducted to verify the electrical interface between the LV and payloads. The test will use flight representative hardware furnished by the LVC and applicable payload components furnished by the payload provider. The test shall include the complete exercise of all electrical interfaces between the LV, separation system and the payload. Integrated test procedures shall be reviewed and approved by participating agencies. The location of the test will be proposed by the LVC.

4.1.2.2 Payload/Launch Site Electrical Compatibility

A design compatibility test to establish high confidence in electrical compatibility of the payloads and their associated GSE with the launch complex will be performed at the launch site. The payload provider will prepare the test procedure and conduct the test. The LVC and the Launch Range will support testing as required. The LVC will only need to provide GSE and support personnel required for the LV and the payload provider will supply all GSE (dependent upon review of the proposed launch site).

4.2 LAUNCH VERIFICATION TESTS

Launch Verification Tests cover the receipt-through-launch processing in support of each flight. An Integrated Field Processing Procedure (IFPP) will be prepared by the test conductor in each test. Contractor formatted test reports are required to verify integrated system launch worthiness; the LVC shall document all anomalies and deviations from the documented procedures. The results of the tests are assessed in post-test readiness reviews, and the test team certifies flight readiness.

4.2.1 Launch Vehicle / Payload Processing

Integrated LV/PL processing is performed in preparation for emplacement on the booster at the launch site. The LVC shall conduct payload integration and mate the payloads to the LV with the payload provider's support.

Payload processing facility (PPF) requirements include a Class 100K payload processing area of at least 1500 sq-ft, and an enclosed GSE area of at least 1050 sq-ft, storage of Electro-Explosive Devices (EED) and use of an overhead crane rated to at least 15,000 lbs. (TBR). Payload provider support personnel will have access to the payload 24/7 for up to a three week period prior to payload integration with the LV.

Primary SV

Control Room – The LVC shall provide a control room for the Primary SV checkout equipment. A fixed CCTV for remote viewing of hazardous activities from the control room will be provided. The control room will be configured as follows:

- 1) Dimensions: TBD
- 2) Largest Door: TBD
- 3) Temperature Range: 23.8 ± 2.8 deg C (75 ± 5 deg F)
- 4) Relative Humidity: Conditioned air without humidity control

Office Space – The LVC shall provide an air-conditioned office space with desks, chairs, file cabinets, and a conference room to accommodate 12 (TBR) personnel.

Transport Requirements – The LVC shall provide transportation of the SV from the PPF to the launch complex. Maximum loads environments for the SV during transportation shall be TBD. The LVC shall provide continuous clean air to the SV throughout the encapsulation, transportation, and mating operations as defined in TBD. Air filtration during transport shall be as defined in TBD. Temperature and humidity control shall be provided to the SV following encapsulation through mating operations at the launch complex as defined in TBD.

Propulsive ESPA:

Control Room – The LVC shall provide a control room for the Primary SV checkout equipment. A fixed CCTV for remote viewing of hazardous activities from the control room will be provided. The control room will be configured as follows:

- 1) Dimensions: TBD

- 2) Largest Door: TBD
- 3) Temperature Range: 23.8 ± 2.8 deg C (75 ± 5 deg F)
- 4) Relative Humidity: Conditioned air without humidity control

Office Space – The LVC shall provide an air-conditioned office space with desks, chairs, file cabinets, and a conference room to accommodate 12 (TBR) personnel.

Transport Requirements – The LVC shall provide transportation of the SV from the PPF to the launch complex. Maximum loads environments for the SV during transportation shall be TBD. The LVC shall provide continuous clean air to the SV throughout the encapsulation, transportation, and mating operations as defined in TBD. Air filtration during transport shall be as defined in TBD. Temperature and humidity control shall be provided to the SV following encapsulation through mating operations at the launch complex as defined in TBD.

ESPA Ring APLs:

Standard ESPA and ESPA ring APLs will have processing capabilities consistent with the ESPA RUG [Ref 5].

4.2.2 Flight Integration Test with Launch Vehicle

The flight integration test shall be performed using the flight hardware to verify electrical compatibility and system performance with the LV upper stack and stages prior to stacking at the launch site. Integrated operations will be performed using procedures approved by participating agencies. The LVC will provide hardware for any LV required tests and the payload provider will provide hardware for any payload required tests.

Primary SV Safety

Safety Design Requirements – Primary SV access through the payload fairing is required to the space vehicle propellant and helium service valves to accommodate contingency propellant offload.

Hazardous Systems / Elements – Primary SV hazardous elements include a bi-propellant propulsion subsystem (Hydrazine and 3% Mixed Oxides of Nitrogen) with Composite Overwrapped Pressure Vessels (COPV) containing high-pressure helium, ordnance in the propulsion pyrovalves, RF subsystem, and mechanisms. SV hazardous systems will be detailed in the SV Missile System Prelaunch Safety Package.

Hazardous Operations – The Primary SV hazardous operations will be detailed in the SV Missile System Prelaunch Safety Package. Hazardous SV operations will include:

- 1) Lifting operations
- 2) Pyrotechnic installation and connection
- 3) Bi-propellant loading and pressurization
- 4) RF radiation
- 5) Payload Materials/Magnet

Propellant, Fluids, and Gases - The LVC shall provide TBD propellant. The Primary SV is required to have the capability for emergency hydrazine offload at the launch complex. In the event of an emergency SV hydrazine offload, the LSC will provide the facilities for accepting and disposing of the offloaded hydrazine through its launch complex hazardous fluid

containment/removal system. The Primary SV will provide interconnect lines between the Primary SV fill and drain valves and the launch complex tank drain and vent interfaces. The Primary SV will maintain readily available, certified propellant loading/offloading personnel throughout the Primary SV's tenure at the launch complex.

Propulsive ESPA:

Safety Design Requirements – Propulsive ESPA access through the payload fairing is required to the Propulsive ESPA propellant and helium service valves to accommodate contingency propellant offload.

Hazardous Systems / Elements – Propulsive ESPA hazardous elements include a bi-propellant propulsion subsystem. Propulsive ESPA hazardous systems will be detailed in the Missile System Prelaunch Safety Package.

Hazardous Operations – The Propulsive ESPA hazardous operations will be detailed in the Missile System Prelaunch Safety Package. Hazardous Propulsive ESPA operations will include:

- 1) Lifting operations
- 2) Pyrotechnic installation and connection
- 3) Bi-propellant loading and pressurization
- 4) RF radiation
- 5) Payload Materials/Magnet

Propellant, Fluids, and Gases - The LVC shall provide TBD propellant. The Propulsive ESPA is required to have the capability for emergency hydrazine offload at the launch complex. In the event of an emergency Propulsive ESPA hydrazine offload, the LSC will provide the facilities for accepting and disposing of the offloaded hydrazine through its launch complex hazardous fluid containment/removal system. The Propulsive ESPA will provide interconnect lines between the Propulsive ESPA fill and drain valves and the launch complex tank drain and vent interfaces. The Propulsive ESPA will maintain readily available, certified propellant loading/offloading personnel throughout the Propulsive ESPA's tenure at the launch complex.

ESPA Ring APLs:

Standard ESPA and ESPA ring APLs safety will be consistent with the ESPA RUG [Ref 5].

4.2.3 Space Vehicle Support Equipment Installation and Ground System Checkout

The SV contractor will install the required SV Support Equipment (SE) at the launch site in locations to be defined in the LV/SV ICD. The SV contractor will test the installed equipment with support from the LVC.

4.2.4 Launch Vehicle/Space Vehicle Emplacement

The payload shall be integrated and encapsulated at a facility near the launch site, mated with the LV, then erected on the launch pad. This process will include mechanical mating, spurious voltage checks, and electrical connection.

4.2.5 Payload Post-Mate Checks

The LVC shall support payload post-mate checks will include the payload operational assurance tests and a compatibility test of the payload and SV systems, and the GSE interfaces. These checks will be conducted at the launch site by the payload provider, after mating with the LV is performed by the LVC.

4.2.6 Mission Simulation Test

The LVC shall perform mission simulation test(s), or other suitable combined systems test, and will include a simulated countdown exercising range interfaces to verify the operational readiness of the entire Aerospace Vehicle Equipment (AVE) and ground system. The term AVE refers to the entire launch system.

4.2.7 Mission Dress Rehearsal

A Mission Dress Rehearsal will be conducted with the entire launch team and will include a simulated countdown, exercising range interfaces to verify the operational readiness of the entire AVE/ground system. In addition, communication only practice countdowns and a “green card” exercise to practice anomaly handling and resolution will be conducted by key members of the launch team.

4.2.8 Launch Day Operations

The launch day operations shall include back-out, prelaunch checkout, launch countdown, and site shutdown. The LVC shall prepare the countdown manual and procedures, incorporating inputs received from the payload provider, Range and RSLP program office (SDL). A Mission Constraints Document will be prepared by the LVC with inputs from the payload provider, and coordinated with SDL.

5.0 ORBITAL TARGETING REQUIREMENTS

5.1 FLIGHT PROFILE

First orbit of 550 km circular orbit @ 45 deg inclination - deployment of propulsive ESPA (with 4 APLs still attached) and 3 APLs from standard ESPA ring

Second orbit of 36,086 +/- 50 km (~GEO + 300 km) at an inclination of zero degrees (0°) - deployment of primary SV and all remaining payloads

5.2 PLUME EFFECTS

The deployment sequence and thruster actions from the LV Attitude Control System (ACS) shall be performed in a manner to minimize interaction of the plumes with the payloads. Plume effects will be verified through analyses by the LVC.

5.3 ACCURACY

Launch vehicle accuracy requirements are defined per the OSP-3 Technical Requirements Document (TRD).

5.4 SEPARATION REQUIREMENTS

Primary SV Separation

Separation Verification - The LV shall monitor the separation circuits and telemetry verification of the SV separation event. Prior to SV separation, the LV shall maneuver so that the SV +X axis (LV longitudinal axis) is pointing to TBD. The LV upper stage inertial attitude rates at SV separation shall be 0.0 +/- 0.1 deg/sec in pitch and yaw and 0.0 +/- 0.25 deg/sec in roll, including 3-sigma dispersions. (TBR) The LV supplied separation system shall impart a relative separation velocity between the SV and the LV upper stage between 1.0 ft/sec and 1.5 ft/sec, including dispersions. (TBR)

Secondary Payload Separation

Separation Verification - The LV shall monitor the separation circuits and telemetry verification of the secondary payload separation events. Prior to each payload separation, the LV shall maneuver so that the payload +X axis (LV longitudinal axis) is pointing to TBD. The LV upper stage inertial attitude rates at SV separation shall be 0.0 +/- 0.1 deg/sec in pitch and yaw and 0.0 +/- 0.25 deg/sec in roll, including 3-sigma dispersions. (TBR) The LV supplied separation system shall impart a relative separation velocity between the SV and the LV upper stage between 1.0 ft/sec and 1.5 ft/sec, including dispersions. (TBR)

5.5 MISSION SPECIFIC C/CAM REQUIREMENTS

The LV shall perform C/CAMs as necessary after each payload deployment to preclude re-contact between the LV and all deployed payloads or other objects (e.g upper half of DPAF), and meet the 3-Sigma mission requirements stated above.

6.0 MISSION SPECIFIC WORK ITEMS

6.1 LEVEL 3 MISSION ASSURANCE ENHANCEMENTS

LVC shall provide all mission assurance support and deliverables as defined in Appendix C. Category 3 Enhancement (EELV) of the OSP-3 Statement of Work

6.2 INTEGRATED PRODUCT TEAMS

The LVC shall participate in the mission IPT as required by the OSP-3 SOW. Other IPT member shall have full and open access to all LVC information relating to this effort.

6.3 DISTRIBUTION

All "A" CDRL deliveries associated with this mission shall add SMC/LR to the distribution list in block 14 of the CDRL.

6.4 ENHANCEMENT 1: PAYLOAD STACK PROCESSING

Provide Integrated Payload Stack Processing for the mission described in this MRD. This will include all engineering, labor, materials, separation systems, adapters and other items necessary to integrate the payloads described in this MRD into an integrated multi-payload stack ready to be mated to the LV. When this enhancement is invoked, the LVC will also act as the payload integrator. The LVC will be provided with the primary SV, the propulsive ESPA assembly with its APLs, and the individual APLs to be integrated onto an ESPA ring. The LVC will be furnished with certified handling equipment required to interface from the crane hook to the payload, if required during the integration process. The LVC shall provide all other items required to create an integrated multi-payload stack. This includes but is not limited to interface adapters, a fixed ESPA ring, payload adapters, the Dual Payload Adapter Fitting (DPAF) for the primary SV, and separation systems.

7.0 ACRONYM LIST

ACS	Attitude Control System
AFSCN	Air Force Satellite Control Network
AVE	Aerospace Vehicle Equipment
C&DH	Command & Data Handling
CG	Center of Gravity
CLA	Coupled Loads Analysis
EGSE	Electrical Ground System Equipment
EMI/EMC	Electromagnetic Interference/Electromagnetic Compatibility
FEM	Finite Element Model
FRR	Flight Readiness Review
GFE	Government Furnished Equipment
GSE	Ground Support Equipment
IBR	Integrated Baseline Review
ICD	Interface Control Document
IFPP	Integrated Field Processing Procedure
ILC	Initial Launch Capability
IRRT	Independent Readiness Review Team
LEO	Low Earth Orbit
LRR	Launch Readiness Review
LTS	Launch Test Squadron
LV	Launch Vehicle
LVC	Launch Vehicle Contractor
MDR	Mission Design Review
MOI	Moment of Inertia
MRR	Mission Readiness Review
NRO	National Reconnaissance Office
OSC	Orbital Sciences Corporation
OSP-3	Orbital Suborbital Program Contract – 3
PFR	Post Flight Review
PSR	Pre-ship Review
RAAN	Right Ascension of the Ascending Node
RF	Radio Frequency
SM-3.2	Sample Mission 3.2
RSLP	Rocket Systems Launch Program
SDTW	Space Development and Test Wing
SE	Support Equipment
SHAR	System Hazards Analysis Report
SMC	Space and Missiles Systems Center
SOH	State of Health
SRR	Systems Requirements Review
SV	Space Vehicle
TBD	To Be Decided
TDM	Technical Direction Meetings
TIM	Technical Interchange Meetings

UNCLASSIFIED//NOT FOR PUBLIC RELEASE SM-3.2 MRD

TRD Technical Requirements Document
UDS Universal Documentation System
VAFB Vandenberg Air Force Base

REFERENCES

Reference 1. OSP-3 TRD

Reference 2. AFSPCMAN 91-710

Reference 3. Range Commander's Council Flight Termination Systems Commonality Standard, Document 319-99, Sept 1999.

Reference 4. RCC 324-01, Global Positioning and Inertial Measurements Range Safety Tracking Systems' Commonality Standard, June 2001

Reference 5, EELV Secondary Payload Adapter Rideshare Users Guide (ESPA RUG), May 2010

Reference 6, Evolved Expendable launch Vehicle Standard Interface Specification, Version 6.0, 5 September 2000.

Note: The Basic Contract takes precedence over any of the cited reference documents should a conflict exist.