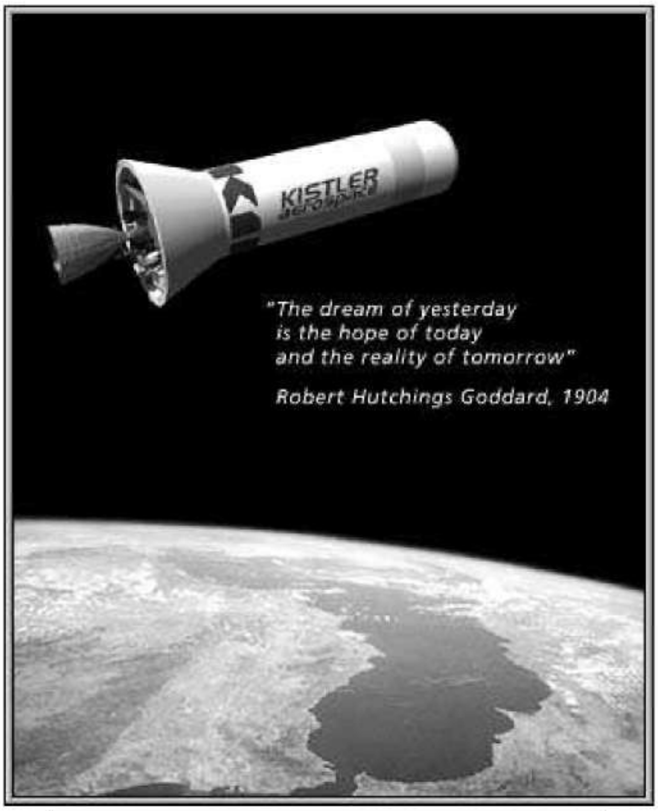
K-1 VEHICLE
PAYLOAD USER'S GUIDE



MAY 1999

K-1 VEHICLE
PAYLOAD USER'S GUIDE

FOREWORD

Kistler Aerospace Corporation is preparing to initiate commercial launch services beginning in 2000 using its fully reusable K-1 launch vehicle. This K-1 Payload User's Guide provides information to potential customers regarding vehicle performance, payload design criteria, payload environments, mission planning and integration, and launch operations and facilities.

This user's guide will be periodically updated. All comments and suggestions for additional information are welcome.

For any clarifications or comments, please contact:

Debra Facktor Lepore
Manager, Payload Systems
Kistler Aerospace Corporation
3760 Carillon Point
Kirkland, Washington 98033
(425) 889-2001
(425) 803-3303
E-mail: dflepore@kistleraero.com

Website: www.kistleraerospace.com

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

ACS	Attitude Control System
amp	ampere
ATP	Authority to Proceed
AWG	American wire gauge
°C	degree Centigrade
CCP	Contamination Control Plan
cm	centimeter
dB	decibel
deg	degree
DFO	(Kistler Woomera) Director of Flight Operations
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EPM	Extended Payload Module
°F	degree Fahrenheit
FAA	Federal Aviation Administration
FPR	flight performance reserves
ft	feet
g	gravity
GEO	geosynchronous orbit
GHz	Gigahertz
GN2	gaseous Nitrogen
GPS	Global Positioning System
HPA	highbay work area
hr	hour
Hz	Hertz, cycles per second
ICD	Interface Control Document
in	inch
INS	inertial navagation system
J-box	junction box
kg	kilogram
kHz	kilohertz
km	kilometer
kPa	kilopascal
LAP	Launch Assist Platform
lbf	pounds force
lbm	pounds mass
LEO	low earth orbit
LN2	liquid nitrogen
LOP	Launch Operations Plan
LOX	liquid oxygen
LRR	Launch Readiness Review
LSRD	Launch Services Requirements Document
m	meter
mA	miliampere

MD	Mission Director
MECO	main-engine cutoff
mg	miligrams
MHz	megahertz
mi	mile
min	minute
mm	milimeters
N	newtons
nmi	nautical mile
OMS	Orbital Maneuvering System
OV	Orbital Vehicle
Pa	Pascal
PPF	Payload Processing Facility
psi	pounds per square inch
Q	damping factor
RAAN	right ascension of ascending node
RF	radio frequency
RMS	root mean square
RP	rocket propellant (kerosene)
Sec	second
SE	support equipment
SMU	Subsystem Management Unit
SPL	Sound Pressure Level
SPM	Standard Payload Module
t	time
TDRSS	Tracking Data Relay Satellite System
TV	television
TVC	thrust vector control
U.S.	United States
V	volts
VHM	vehicle health maintenance
VMC	Vehicle Management Computer
VPF	Vehicle Processing Facility
WPA	Woomera Prohibited Area

---

1. INTRODUCTION

Kistler Aerospace Corporation is developing the world's first commercial, fully reusable aerospace vehicle. The two stage K-1 vehicle is designed to significantly reduce the cost of reliably delivering payloads to Low Earth Orbit (LEO) and to provide rapid launch response and schedule flexibility. This User's Guide describes the K-1 vehicle, its performance capabilities, payload environments and interfaces, and Kistler's approach to launch operations and services.

1.1 K-1 Program Overview

Kistler Aerospace Corporation has assembled a team of preeminent aerospace experts and space program managers to design the K-1 vehicle and manage the K-1 program. Collectively, these individuals have guided most of America's major space programs, including Redstone, Mercury, Gemini, Saturn, Apollo, Skylab, the U.S. Space Shuttle and the International Space Station.

Kistler is leading the K-1 systems engineering and integration effort through an integrated team composed of Kistler and contractor personnel. Each of Kistler Aerospace's contractors is a leader in its respective field of the aerospace industry and has significant experience in the construction of similar components. The team includes Lockheed Martin Michoud Space Systems, Northrop Grumman Corporation, GenCorp Aerojet, Draper Laboratory, Allied Signal Aerospace, Irvin Aerospace and Oceaneering Thermal Systems. Table 1-1 summarizes the responsibilities of the K-1 team companies.

The flight test program is scheduled to commence during early 2000 from the Woomera launch facilities in southern Australia. Commercial operations will start immediately thereafter. As launch rates increase, parallel operations will be initiated in 2002 from a site at the Nevada Test Site near Las Vegas, Nevada. Regulatory efforts are well underway for both sites.

Organization	Responsibilities	Individual Management Experience
	Customer services, systems engineering and integration, launch system development, launch operations	Redstone, Mercury, Gemini, Saturn, Apollo, Skylab, U.S. Space Shuttle, International Space Station
Organization	**Responsibilities**	**Relevant Technology Experience**
	Liquid oxygen tanks, LAP fuel tank, ablator thermal protection	U.S. Space Shuttle external tank, X-33 RLV demonstrator
	LAP and OV structural components, OV fuel tank, payload module, TCS	B-2 bomber, Boeing 777 components, F/A-18E/F structures
	Modifications and testing of AJ26 engines, OMS, ACS, pressurization system, feedlines, gas bottles	Delta II, Titan IV
	GNC system, flight vehicle software development and testing (IV&V, HWIL)	U.S. Space Shuttle, Apollo, DOD programs
	Avionics hardware, software and vehicle management system	X-33, Iridium, Space Telescope, Skylab, Galileo
	Parachutes, landing airbags, activation and control systems	U.S. Space Shuttle, F-111, CL-289, NATO drone, EELV, DOD satellite recovery systems
	Thermal protection system (tiles and blankets) on both stages	U.S. Space Shuttle

Table 1-1. K-1 Program Team

1.2 Summary of Available Launch Services

Kistler provides turnkey launch services. Launch services include: program management, planning and scheduling; mission analysis and planning; configuration management; payload/launch vehicle integration; system safety; coordination of launch regulatory requirements; and launch operations. If desired, Kistler will develop and qualify a satellite dispenser to customer requirements. Kistler can also provide special transportation, logistics, and other support services.

Two wholly owned Australian companies perform K-1 launch operations at Woomera, Australia. Kistler Woomera Pty. Ltd. is responsible for flight operations, related engineering and technical support, and maintaining the launch pad and tank farm. Spaceport Woomera Pty. Ltd. is responsible for infrastructure and logistics support, including general maintenance of the launch site and other facilities. Kistler Aerospace Corporation serves as the single point of contact for customers, and subcontracts and coordinates activities in Australia with its two subsidiaries on behalf of customers.

1.3 Mission Management

At contract award, Kistler assigns an experienced Mission Manager who is responsible for ensuring customer satisfaction. The Mission Manager arranges and directs all necessary resources to successfully complete the launch campaign, and serves as a single-point-of-contact for all mission-related technical and programmatic activities.

Each customer is involved in the development of launch service requirements, payload-to-launch vehicle interfaces, and operations procedures through the establishment of joint integration, mission planning, and operations working groups. For the reusable K-1 vehicle, the critical path to the first launch for a customer is development of a payload-unique dispenser. Once this dispenser is developed and basic mission analyses are complete, the K-1 vehicle can offer rapid call-up launches for delivery of critical on-orbit assets.

1.4 Key Customer Advantages

Use of the K-1 reusable aerospace vehicle to deliver payloads to LEO provides significant advantages to our customers:

- Cost competitive launch services
- Reliable missions through repeated use of proven vehicles
- Rapid response launches
- Launch schedule flexibility
- Streamlined launch process flow
- Highly accurate orbit insertion
- Advantageous payment schedules.

Kistler is dedicated to ensuring that each launch campaign results in successful, on-time, accurate delivery of the customer's payload.

2. K-1 VEHICLE OVERVIEW

This section provides an overall description of the Kistler K-1 reusable aerospace vehicle.

2.1 Launch Vehicle Description

The K-1 vehicle is a two-stage, fully reusable aerospace vehicle. The overall K-1 vehicle is 36.9 m (121 ft) long and weighs 382,300 kg (841,000 lbm) at liftoff. The K-1 vehicle is shown in Figure 2-1.

The first stage, or Launch Assist Platform (LAP), is 18.3 m (60 ft) long, 6.7 m (22 ft) in diameter, and weighs 250,500 kg (551,000 lbm) at launch. The second stage, or Orbital Vehicle (OV), is 18.6 m (61 ft) long, has a cylindrical diameter of 4.3 m (14 ft), and weighs 131,800 kg (290,000 lbm) fully-fueled. Each stage carries its own suite of redundant avionics and operates autonomously.

2.1.1 Launch Assist Platform

The three liquid oxygen (LOX)/ kerosene engines of the LAP are high performance, robust engines which combine the best of Russian and U.S. technologies. The two AJ26-58 engines and one AJ26-59 engine include the fully developed, extensively tested core of the NK33/43 engines originally built for the Russian Manned Moon Program. The engines have been modified to include modern U.S. electronic controllers, ignition systems, control valves, and thrust vector control (TVC) systems.

The three LAP engines provide 4,540 kN (1,020,000 lbf) of total thrust at liftoff. These engines have an expansion ratio of 27:1 and are capable of being hydraulically gimbaled to ± 6-degrees in pitch and yaw. Following stage separation, the center AJ26-59 engine is restarted to return the LAP to the launch site.

Other major subassemblies of the LAP include the composite interstage, aluminum liquid oxygen (LOX) tank, composite intertank, aluminum fuel tank, a retention tank to contain the LOX necessary.

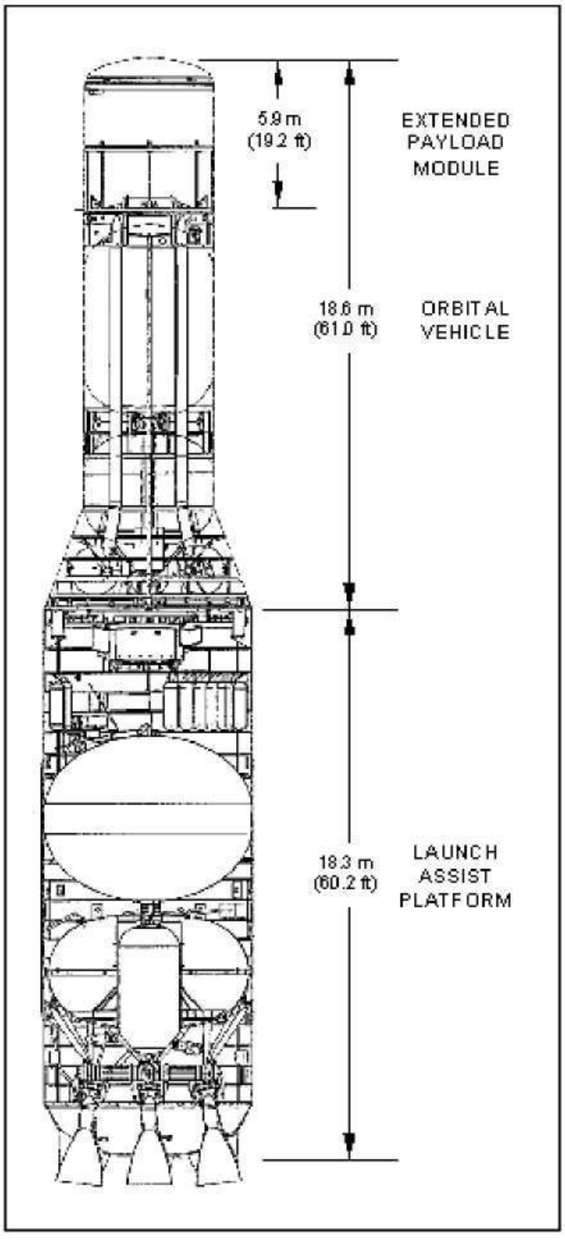


Figure 2-1. K-1 Vehicle Profile

for the flyback to the launch site, and the composite aft skirt. Four cold gas thruster pods provide attitude control during LAP separated flight. Tank pressurization is performed using helium. The avionics system is located in the intertank compartment.

Two drogue parachutes and two clusters of three main parachutes are used to decelerate the LAP for a soft touchdown using four low-pressure airbags.

Figure 2-2 shows an overview of the LAP configuration.

2.1.2 Orbital Vehicle

The OV uses one AJ26-60 engine for main propulsion. The AJ26-60 provides 1,760 kN (395,000 lbf) vacuum thrust with an expansion ratio of 80:1. The engine is hydraulically gimbaled to provide thrust vector control. After LAP separation, the AJ26-60 engine ignites for a typical 230 second burn to place the vehicle in an elliptical orbit with an apogee at the deployment altitude. Following a coast to apogee, the LOX/ethanol Orbital Maneuv-ering System (OMS) fires to circularize the orbit.

After payload deployment, the OMS fires again to place the OV into a phasing orbit with the correct period for re-entry. Following a second coast phase of up to 22 hours, the vehicle reorients, performs a de-orbit burn with the OMS, and reenters the earth's atmosphere. The OV flies a guided re-entry trajectory to the launch site. A high-altitude stabilization chute is deployed at Mach 2.5, followed by deployment of a single drogue and three main chutes. The main parachutes decelerate the stage for a soft touchdown using four low-pressure airbags.

Other major subassemblies of the OV include the composite forward skirt, aluminum LOX tank, composite intertank, composite fuel tank and composite flare. Tank pressurization is performed using helium. Four cold gas thruster pods provide stage attitude control during separated flight. The avionics system is located in the forward compartment behind the payload module.

An overview of the OV configuration is shown in Figure 2-3.

2.1.3 Payload Modules

The K-1 vehicle offers the customer two payload module configurations. The Standard Payload Module (SPM) and the Extended Payload Module (EPM) are described in detail in Section 4. The payload modules are fabricated from composite materials and use redundant, high-reliability mechanisms. Both payload module configurations incorporate interior acoustic absorption blankets and have integral pre-launch environmental control systems.

The payload modules are vertically integrated with the payload in the Payload Processing Facility. Payload modules are interchangeable to provide maximum flight schedule flexibility. Payload integration operations are described in Section 8.5.

2.1.4 Avionics and Flight Software

Each stage of the K-1 vehicle is completely autonomous from launch to landing. Stage guidance and control are provided by a triple-redundant, fault-tolerant avionics architecture.

Vehicle position, velocity and orientation data are provided by three integrated Global Positioning System (GPS) / Inertial Navigation System (INS) units. Vehicle command and control is managed by the Vehicle Management Computer (VMC) and supported by distributed Subsystem Management Units (SMUs) which are responsible for valve actuation, pyro initiation, and subsystem health monitoring. The main engines and OMS each have their own control units that perform the same functions. Data communications are conducted using a triple-redundant 1553 data bus.

The K-1 vehicle avionics includes a Tracking Data Relay Satellite System (TDRSS) transce iver for communicating vehicle status to the ground and for updating OV wind data for re-entry targeting. TDRSS is also used to provide the customer with payload deployment data to support ground station acquisition. Kistler is responsible for scheduling the use of TDRSS with NASA.

All mission software is fully verified prior to flight in a hardware-in-the-loop system operated by Draper Laboratory.

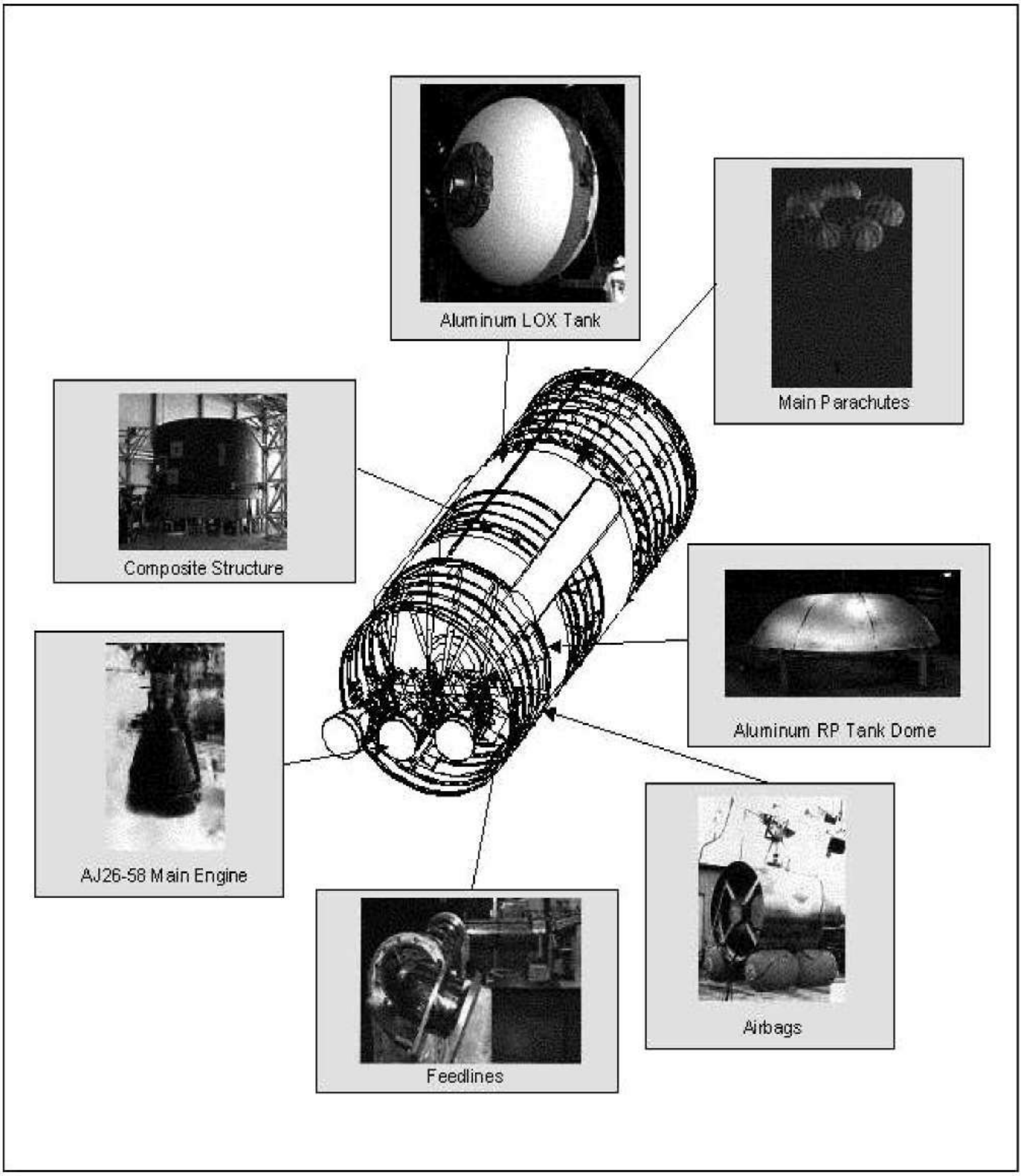


Figure 2-2. Launch Assist Platform (LAP) Overview

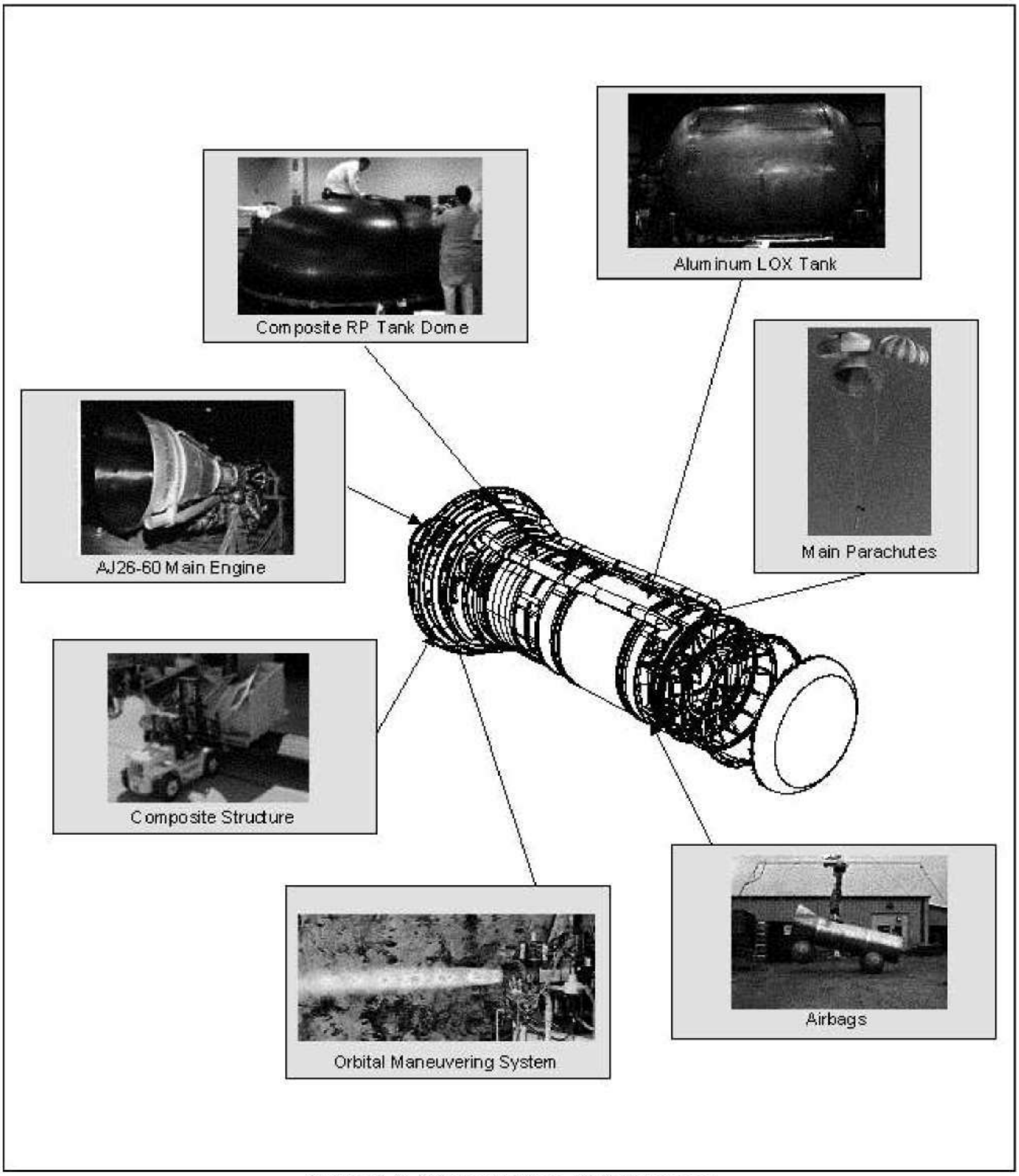


Figure 2-3. Orbital Vehicle (OV) Overview

2.2 Vehicle Axes / Attitude Definitions

The K-1 vehicle coordinate system is given in Figure 2-4. The X-axis is along the longitudinal axis of the vehicle. The Y-axis is the pitch axis. The Z-axis is the yaw axis. The directions of positive roll, pitch, and yaw follow the right-hand rule.

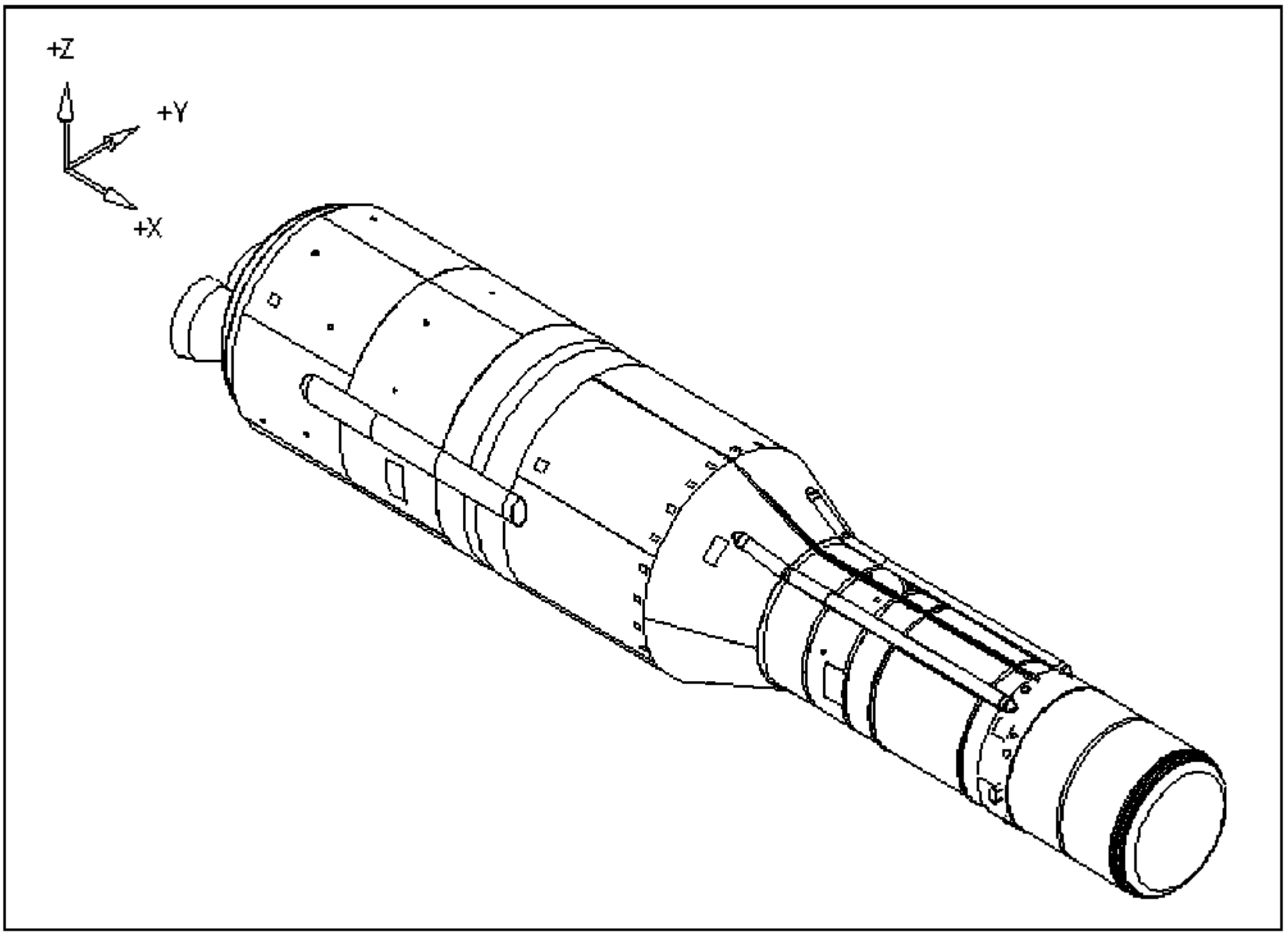


Figure 2-4 . K-1 Vehicle Coordinate System

3. K-1 VEHICLE PERFORMANCE

This section defines the payload performance capability of the K-1 vehicle to low earth orbit. Kistler has under study options for the delivery of payloads to higher orbits using expendable upper stages. Performance for these missions will be added to future versions of the K-1 vehicle Payload User's Guide as this capability becomes available.

3.1 Launch Sites

Kistler is developing two launch sites for the operation of the K-1 vehicle. Spaceport Woomera is located at Woomera, Australia (31.08° South latitude, 136.66° East longitude). Spaceport Nevada is at the Nevada Test Site near Las Vegas, Nevada, USA (37.17° North latitude, 116.27° West longitude). Table 3-1 provides the flight corridors offered by the K-1 from the Woomera and Nevada launch sites for initial commercial operations. Expansions of these corridors will be pursued as requirements are defined.

Woomera, Australia		Nevada, USA	
Azimuth Range*	Inclination Range	Azimuth Range*	Inclination Range
55 to 33 deg	45 to 60 deg	62 to 36 deg	45 to 60 deg
5 to –14 deg	84 to 99 deg	5 to –14 deg	84 to 99 deg

* Azimuth is degrees from North

Table 3-1. Flight Azimuths and Inclinations

3.2 Mission Profiles

The K-1 vehicle ascent, payload deployment, and post-deployment maneuvers are described in this section.

3.2.1 Ascent Profile

The K-1 vehicle ascent profile for a 900 km mission is summarized in Figure 3-1. Stage separation occurs at 139 seconds into the mission at an altitude of 43.2 km (142,000 ft) and a velocity of 1.22 km/sec (4,000 ft/sec). The LAP center engine re-ignites 4.4 seconds after separation to return the stage to the launch site.

The OV main engine ignition occurs 7.3 seconds after separation. OV main engine cutoff occurs at an altitude of 94.4 km (310,000 ft) and a velocity of 7.8 km/sec (25,600 ft/sec). The OV then coasts to the targeted orbit altitude at which time the OMS engine fires to circularize the orbit. Final orbit insertion is complete approximately 60 minutes into the mission. Payload deployment occurs approximately 60-90 minutes into the mission. Typical ascent acceleration, altitude, and velocity profiles are provided in Figures 3-2 and 3-3. The mission event sequence is shown in Table 3-2.

3.2.2 Payload Deployment

Following OV orbit insertion, the attitude control system (ACS) is used to damp out any residual attitude rates and orient the vehicle in the required attitude. The payload module dome is opened and payload deployment is initiated. Separation data are immediately sent to the ground operations center using TDRSS and are provided to the customer to support ground station payload acquisition. A deployment sequence is shown in Figure 3-4 for a payload deployed forward along the velocity vector.

3.2.3 Collision and Contamination Avoidance Maneuvers

The OV post-deployment maneuvers are designed to eliminate the possibility of re-contact with or contamination of the customer's payload. A representative post-deployment clearance profile is shown in Figure 3-5. Following deployment, the dispenser and payload module are prepared for re-entry. These operations take approximately 12 minutes, during which time the cold gas ACS system is disabled. When the ACS system is enabled for rate-damping operations, the OV is greater than 200 m (660 ft) from the customer's payload assuming a minimum separation velocity of 0.3 m/sec (1 ft/sec). The OV then coasts until the proper time to orient for the OMS phasing burn.

Sufficient clearance after deployment is provided to eliminate any collision or contamination concerns. The phasing burn is required to establish the proper orbit period to allow the OV to return to the launch site. Depending on the deployment altitude, the phasing burn can either raise apogee or lower perigee. In either case, the typical phasing orbit is elliptical with a different orbit period than that of the deployed payload.

The phasing burn occurs approximately 90 minutes after payload separation. At this time, the OV and the payload are greater than 5 km (2.7 nmi) apart. At this distance, OMS plume contamination and environmental issues are eliminated.

The distance between the OV and the payload is greater than 1000 km (540 nmi) 5 hours after the phasing burn, and continues to increase because of the difference in orbit periods.

3.3 Performance Capability

This section presents the K-1 payload capability. Data are provided for both Standard and Extended Payload Module configurations. The performance estimates are based on propellant budgets that include 3-sigma flight performance reserves (FPR).

The K-1 vehicle is designed primarily to deliver payloads to circular low earth orbits. The K-1 vehicle LEO performance is provided in Figures 3-6 and 3-7 for several specific orbit inclinations. Payload capability for other orbits can be obtained by interpolation. Performance to elliptical or higher energy orbits can be addressed on a case-by-case basis.

Customers are welcome to contact Kistler Aerospace to discuss specific mission requirements and associated payload performance.

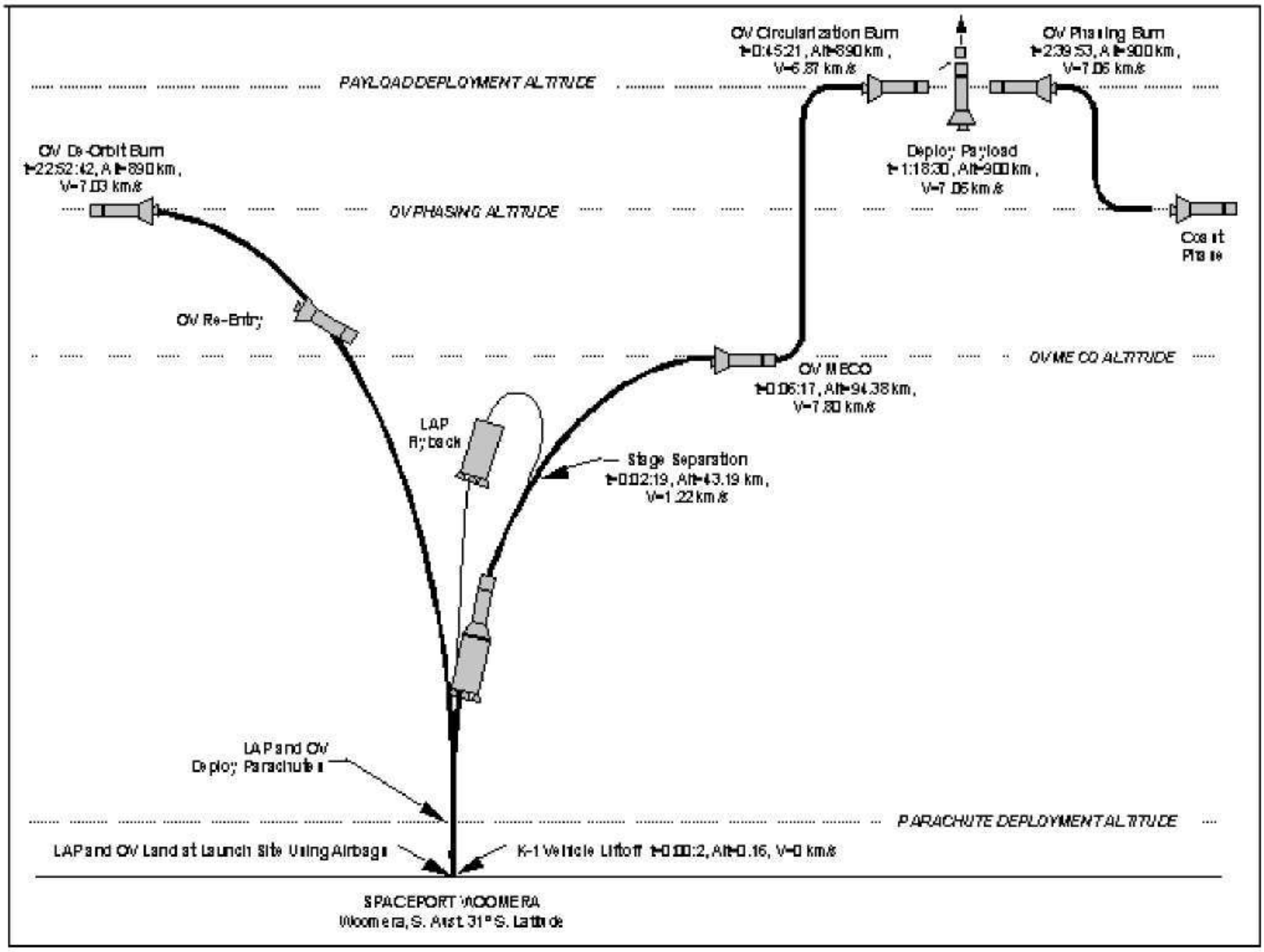


Figure 3-1. K-1 Vehicle Ascent Profile

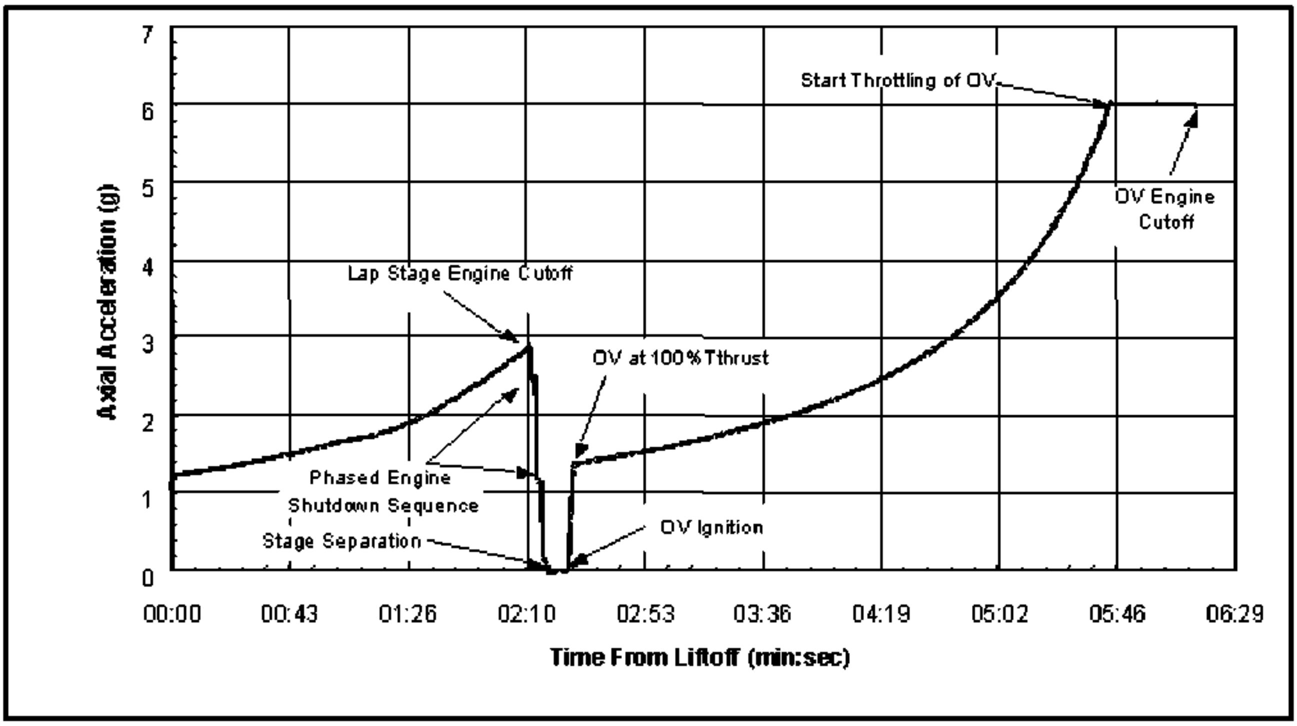


Figure 3-2. Ascent Acceleration Profile

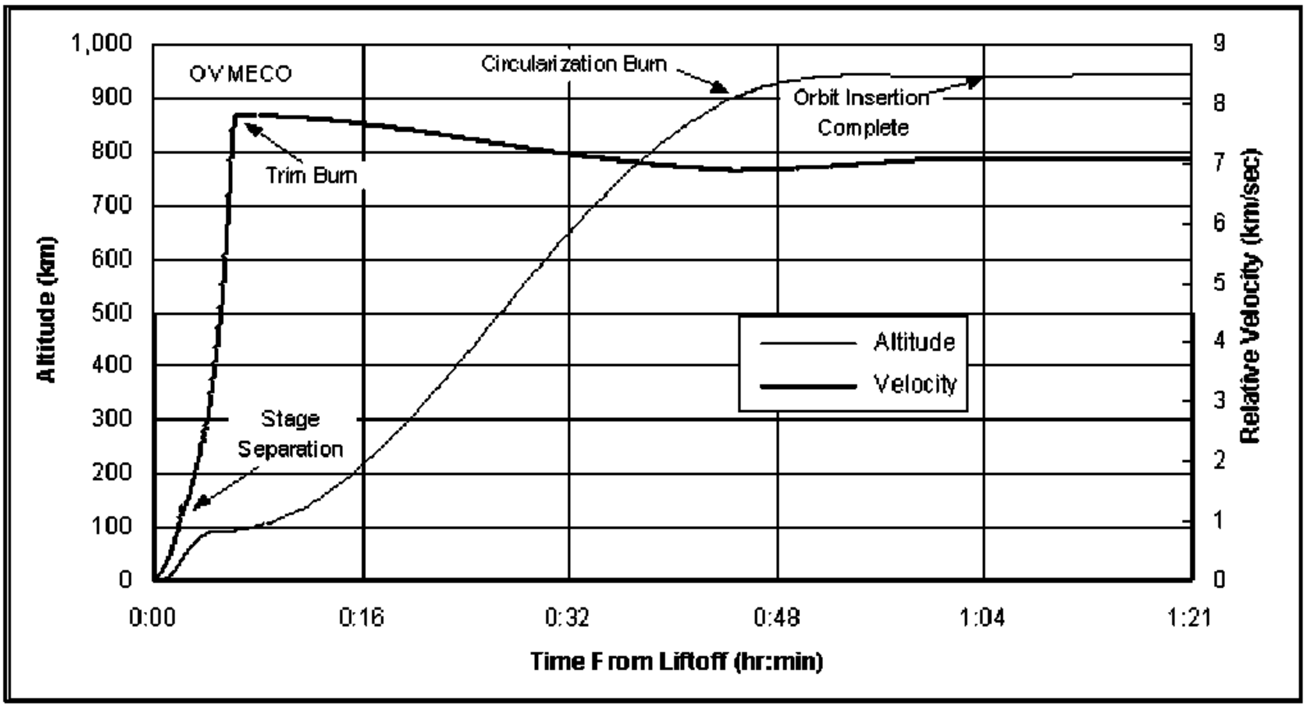


Figure 3-3. Ascent Altitude and Velocity Profile

Event	Time (hr:min:sec)	Altitude (km)	Relative Vel (km/s)
K-1 arrives at pad	-6:30:00	0.16	0
Launch vehicle to vertical	-4:10:00	0.16	0
Pad checkout (automatic)	-4:00:00	0.16	0
Chilldown and loading of propellants	-3:45:00 to –1:20:00	0.16	0
Final/wet checkout	-1:00:00	0.16	0
Vehicle switches to internal power	-0:01:15	0.16	0
Engine pre-ignition sequence	-0:00:45	0.16	0
LAP engines start	0:00:00	0.16	0
Liftoff	+0:00:02	0.16	0
Vehicle begins pitch-over	+0:00:11	0.32	0.03
Maximum Q-α	+0:01:18	10.38	0.35
Maximum Q	+0:01:22	11.74	0.39
Engines begin throttle down	+0:02:14	38.61	1.18
Stage separation	+0:02:19	43.19	1.22
OV engine starts	+0:02:26	47.93	1.18
Maximum g-limiting begins	+0:05:45	94.29	5.96
OV MECO	+0:06:17	94.38	7.80
Trim burn	+0:07:17	98.29	7.79
Circularization burn	+0:45:21	890.00	6.87
Payload module open	+1:12:00	900.00	7.06
Final attitude trim prior to payload deployment	+1:12:00	900.00	7.06
Nominal payload deployment	+1:18:30	900.00	7.06
Phasing burn	+2:39:53	900.00	7.06
De-orbit burn	+22:52:42	890.00	7.03

Table 3-2. Mission Event Sequence For 900 km Orbit Woomera Launch–

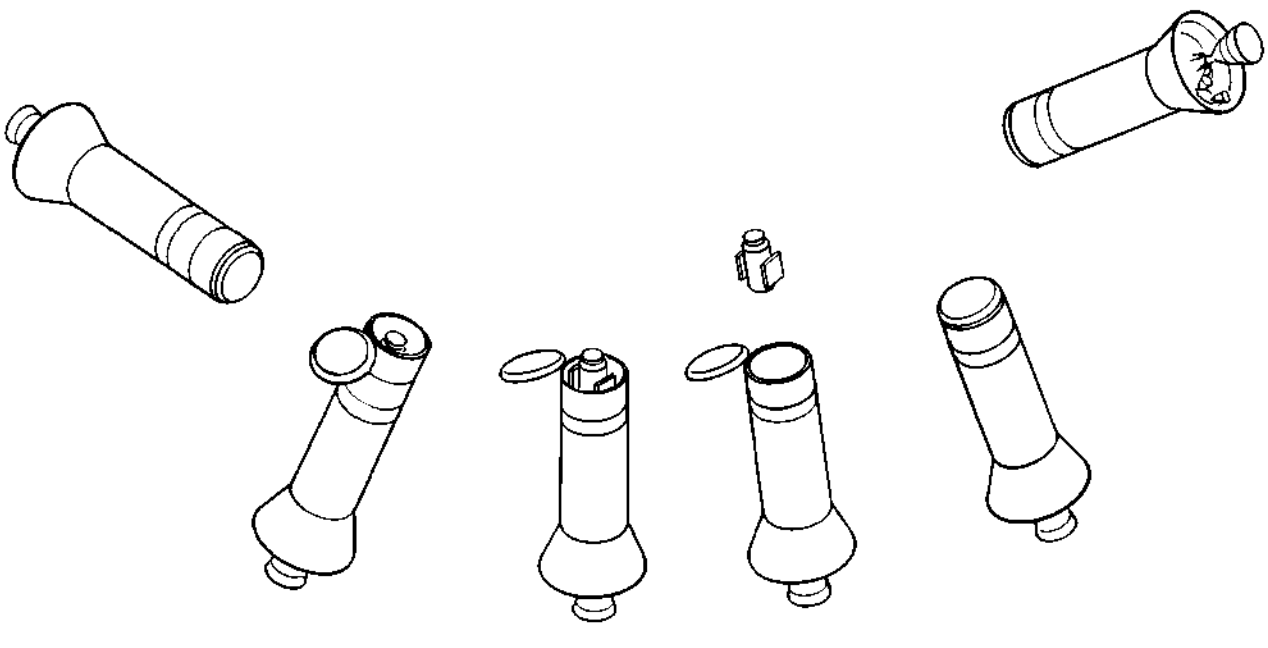


Figure 3-4. Payload Deployment Sequence

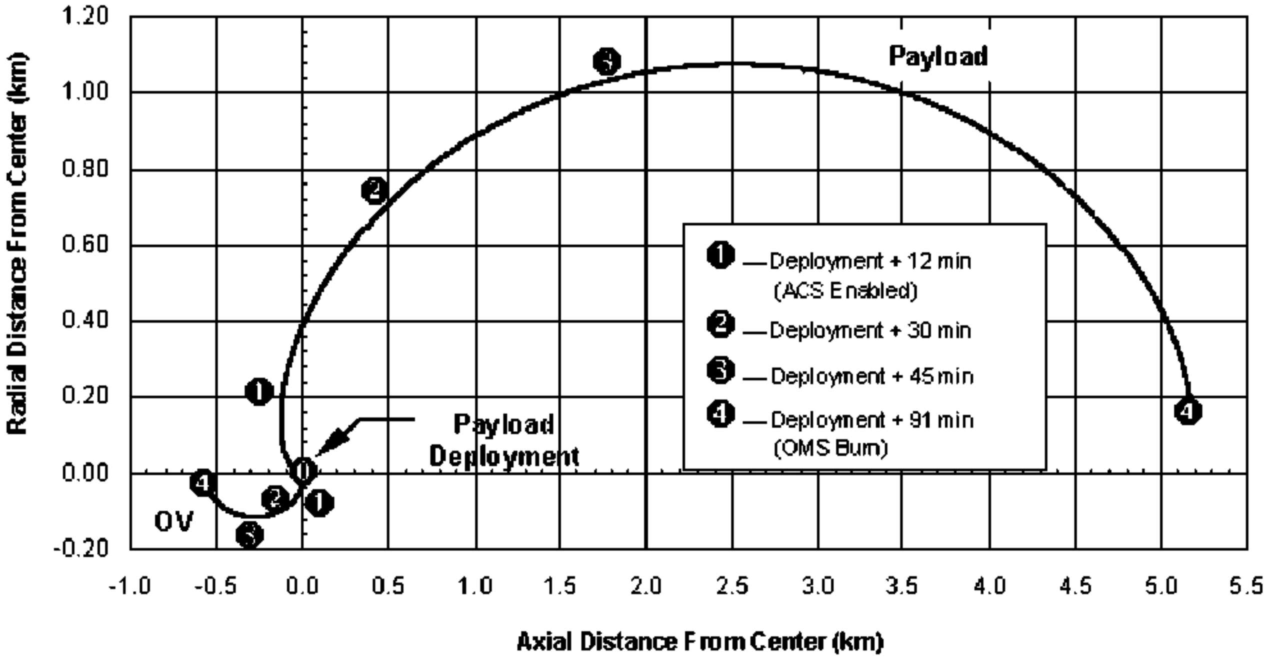


Figure 3-5. Post-Deployment Clearance

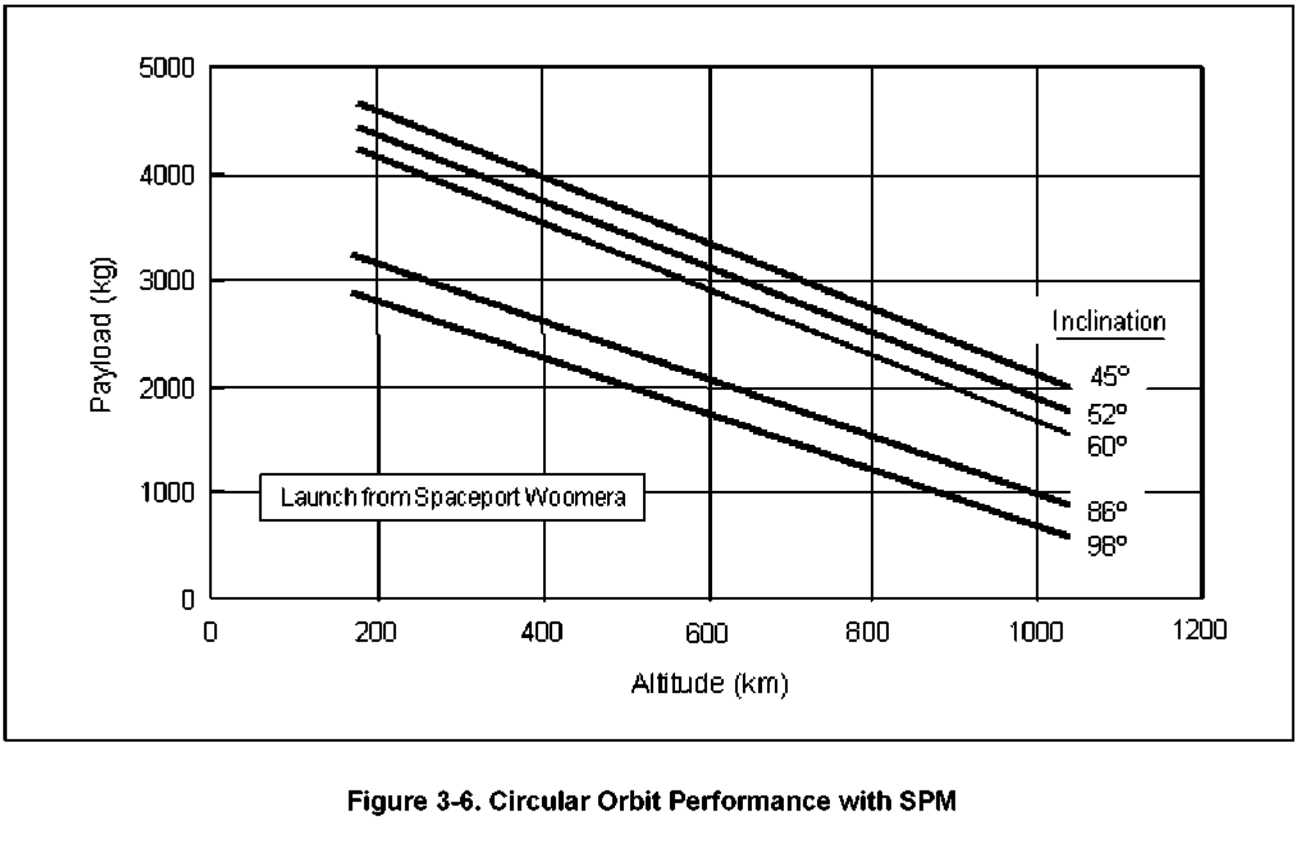


Figure 3-6. Circular Orbit Performance with SPM

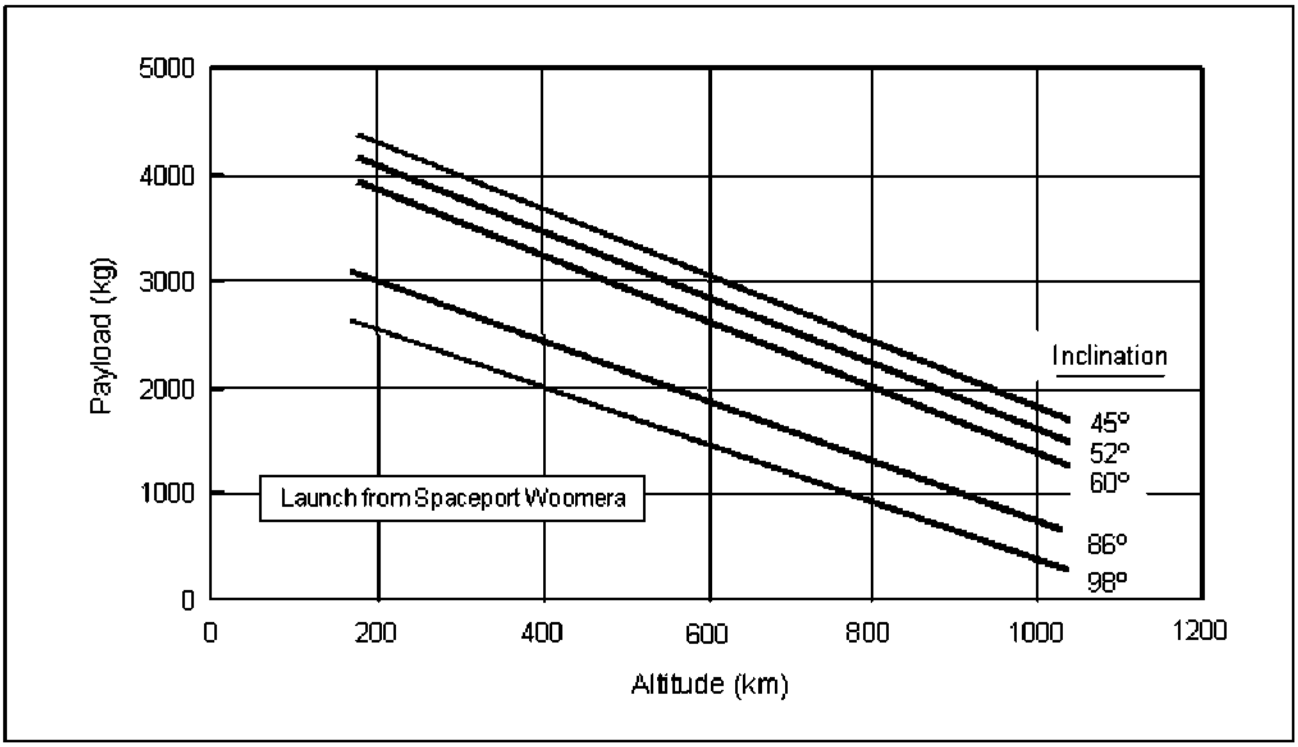


Figure 3-7. Circular Orbit Performance with EPM

3.4 Orbit Insertion Accuracy

The K-1 vehicle orbit insertion accuracy is summarized in Table 3-3. Highly accurate orbit insertion is ensured through the use of the OV OMS to correct post-MECO velocity errors and to provide final orbit insertion. These accuracies are valid for all orbits 1000 km.

Table 3-3. Orbit Injection Accuracy

Parameter	K-1 Accuracy (3σ)
Orbit altitude	± 10 km
Eccentricity	± 0.01
Inclination	± 0.05 degrees
Right Ascension of Ascending Node (RAAN)	± 0.04 degrees

4. K-1 PAYLOAD MODULE

Payloads are carried by the K-1 vehicle inside the reusable payload module mounted on top of the OV. This section describes the payload module and its operation.

4.1 General Description and Operation

The K-1 payload module performs the same function for the payload as does the fairing of an expendable vehicle. In contrast to a typical fairing, however, the K-1 payload module is fully reusable and provides the forward reentry heat shield for the OV.

Figure 4-1 shows the K-1 payload module. The structure consists of a composite cylindrical section sealed at the top with a dome. The payload dispenser is mounted to the bottom deck of the payload module. Payload purge and electrical interfaces are provided at the base. The inside surface is covered in acoustic blankets. The outer surface is covered with thermally-protective materials to withstand reentry heating.

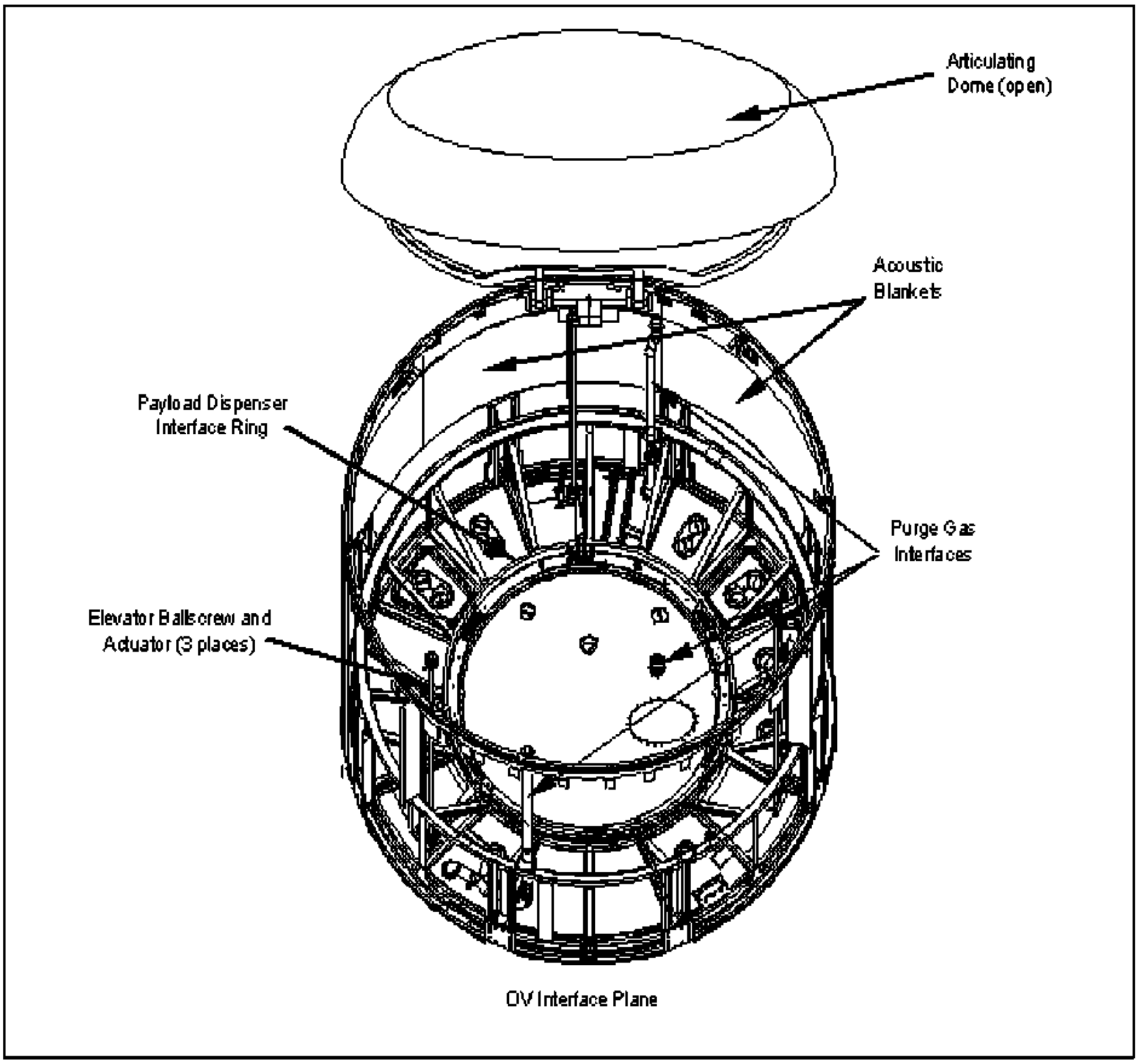


Figure 4-1. Standard Payload Module

During pre-launch operations, the payload module is placed in the payload processing facility for maintenance and payload integration. It is then moved to the vehicle processing facility for final mating with the OV prior to launch. A purge is maintained for payload temperature control from final encapsulation until launch.

During ascent, the payload module remains closed around the payload until completion of orbit insertion. As a result, no payload molecular heating is experienced during ascent. After the payload insertion orbit is achieved, the payload module dome opens to allow for payload deployment.

The exact deployment sequence depends on the configuration. The K-1 vehicle offers both a standard payload module (SPM) and an extended payload module (EPM). The EPM has about twice the usable height of the SPM.

Figure 4-2 shows one operating sequence for the SPM. The dome is opened and the payload is deployed axially. The dome is then retracted and secured.

Figure 4-3 shows a second operating sequence for the SPM. After the dome is opened the base on which the dispenser is mounted is raised to allow radial deployment of the payload. Three dual-redundant motorized screwjacks are used to raise the base. After deployment, the base is lowered and the dome secured.

Figure 4-4 shows an operating sequence for the EPM. To establish a suitable aerodynamic configuration for re-entry, the forward cylindrical section is retracted over the aft section after the dome is opened using another set of three redundant motorized screwjacks. After this configuration is achieved, all other operations are the same as for the SPM.

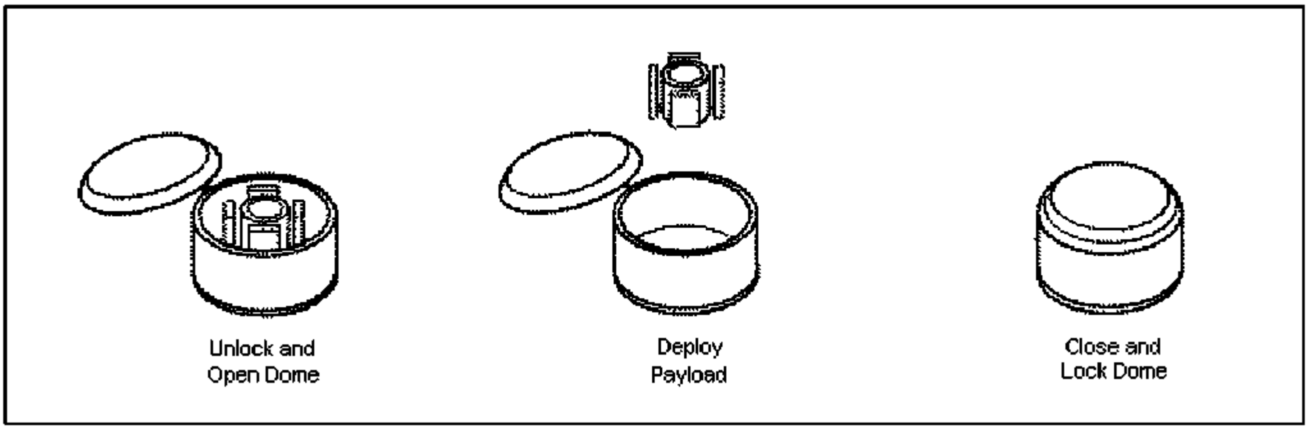


Figure 4-2. Axial Payload Deployment – Standard Payload Module (SPM)

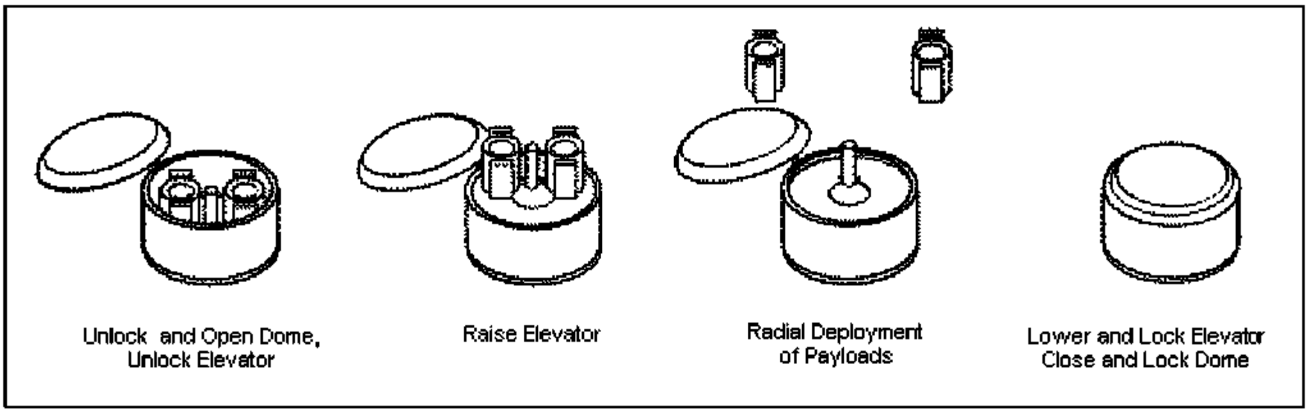


Figure 4-3. Radial Payload Deployment – Standard Payload Module (SPM)

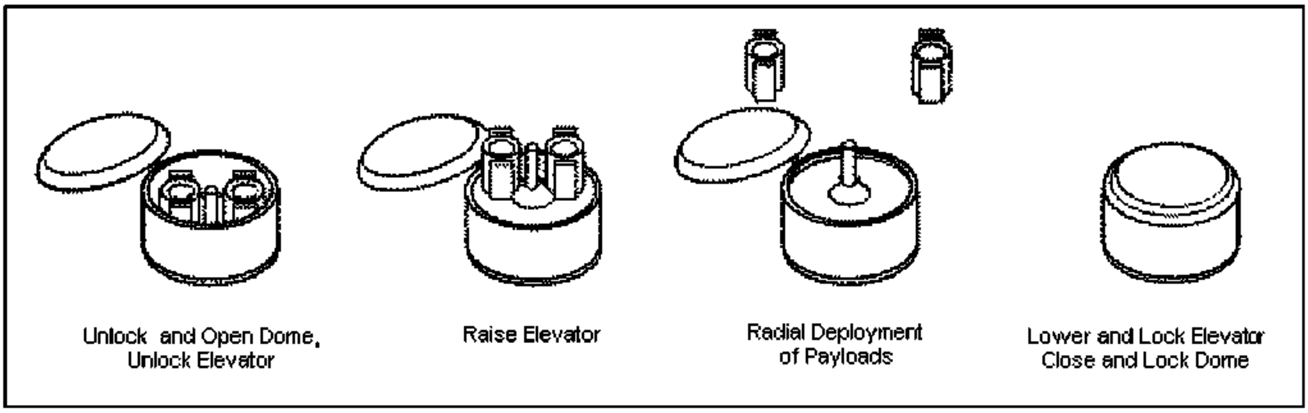


Figure 4-4. Axial Payload Deployment – Extended Payload Module (EPM)

4.2 Payload Envelope

The allowable dynamic envelope within the payload module for the combined payload/dispenser is shown in Figure 4-5 for both the SPM and EPM.

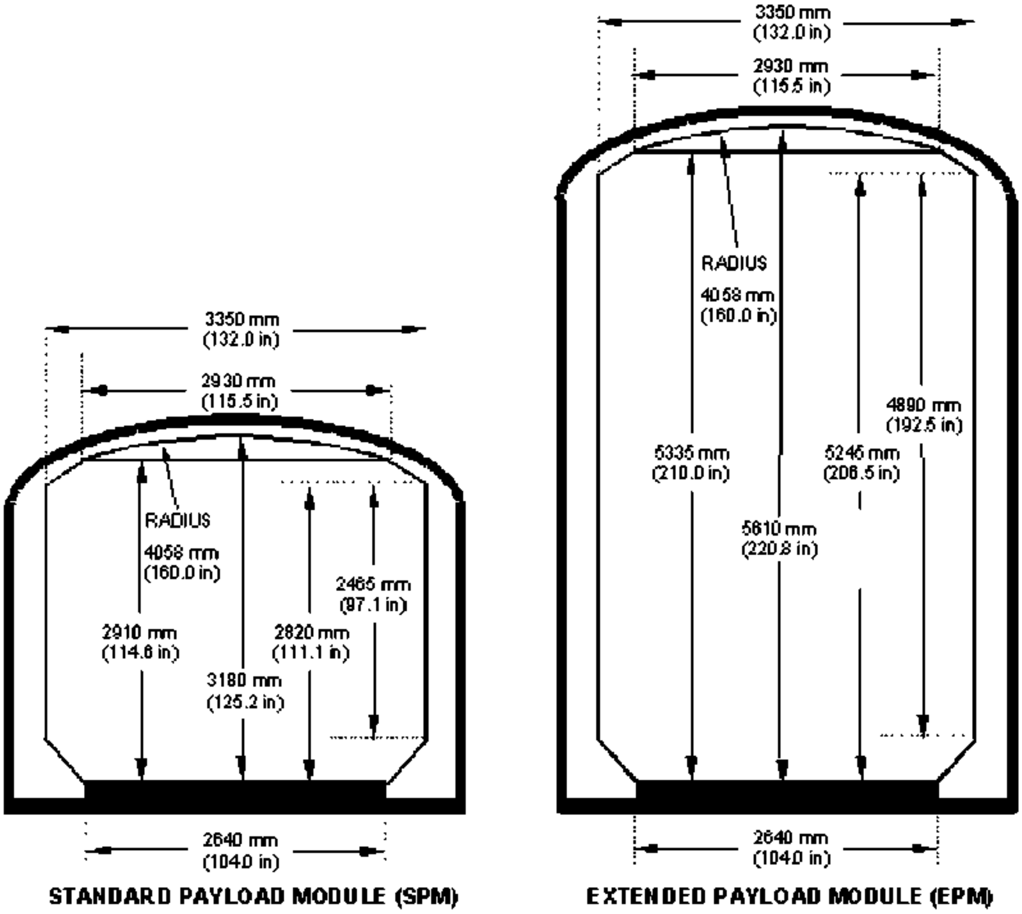


Figure 4-5. Combined Payload/Dispenser Dynamic Envelopes

5. PAYLOAD INTERFACES

This section describes the mechanical and electrical interfaces between the K-1 payload module and the payload/dispenser. The reusable K-1 vehicle allows for refurbishment and reuse of the payload dispenser. The dispenser can either be supplied by the customer or developed by Kistler to customer requirements.

5.1 Mechanical Interfaces

The payload dispenser provides the interface between the payload and the payload module. Reusable payload dispensers can be provided to meet the interface requirements of the customer, including standard V-band clamp systems or custom bolted interfaces. The specific design and development approach is arranged with each customer. The dispenser mounts to the dispenser attach ring using thirty evenly spaced bolts. Figure 5-1 shows this interface.

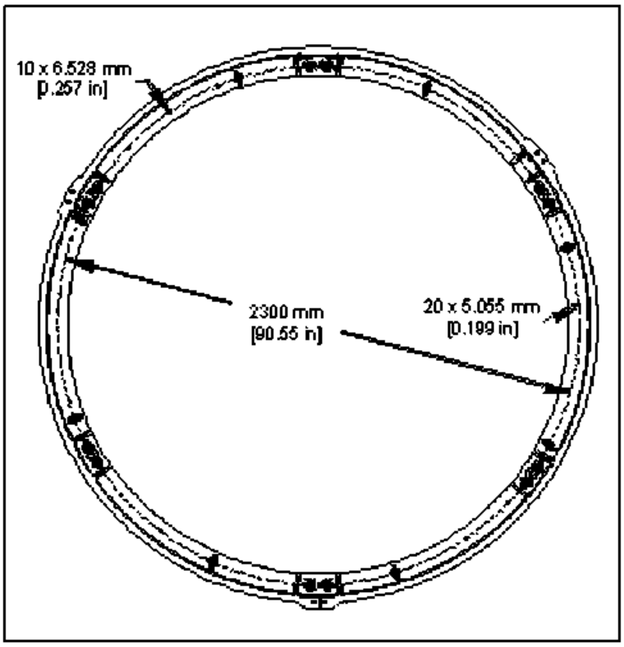


Figure 5-1. Dispenser Mechanical Interface

5.2 Electrical Interfaces

The electrical interface with the payload is made through a dedicated umbilical following final integration of the payload/dispenser with the payload module. This umbilical provides ground power, battery charging, and hardwired command and telemetry links between the payload and the customer-supplied ground support equipment (GSE). The customer GSE is located in the Terminal Room under the launch pad. Fiber optic control lines are provided for remote operation of the GSE from the payload processing facility (PPF). Figure 5-2 shows an overview of customer electrical interfaces at the launch site. A total of eighty-four 16-gauge wires are available for customer use in the payload umbilical. The flyaway payload umbilical is available for use until liftoff.

In addition to the payload umbilical, two vehicle harnesses are dedicated to the payload separation system and one to separation indication. The vehicle avionics are capable of simultaneously issuing six 6-amp pyro commands through redundant channels. The vehicle avionics also provide three payload-to-dispenser low level (5 mA) separation circuits that can be used for either breakwires or switches. The vehicle flight computer monitors the separation discrete circuits.

Separation circuits that indicate deployment to the payload can also be accommodated. The complete electrical interface between the OV and the payload/dispenser is shown in Figure 5-3.

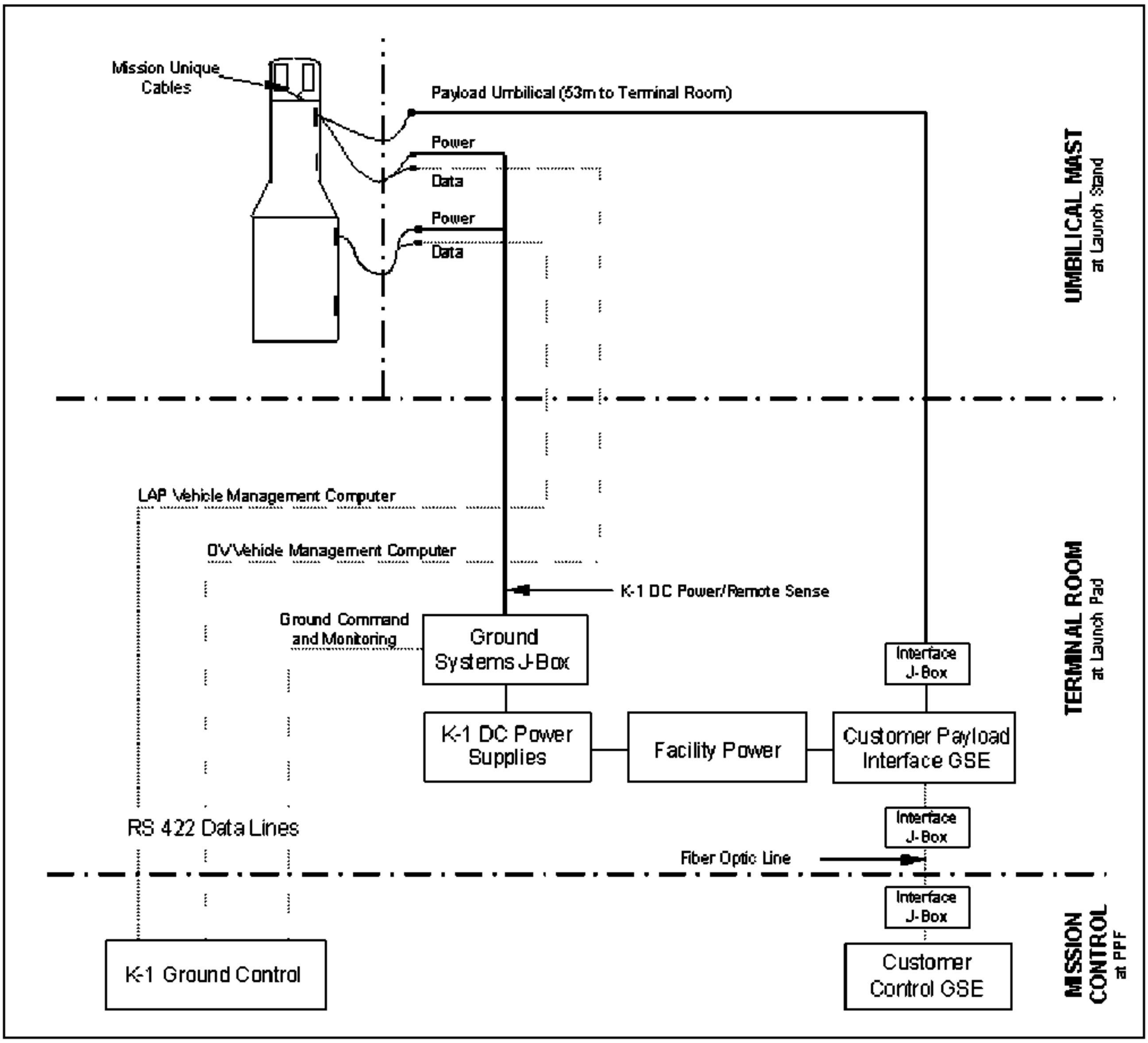


Figure 5-2. Customer and Launch Control Electrical Interfaces

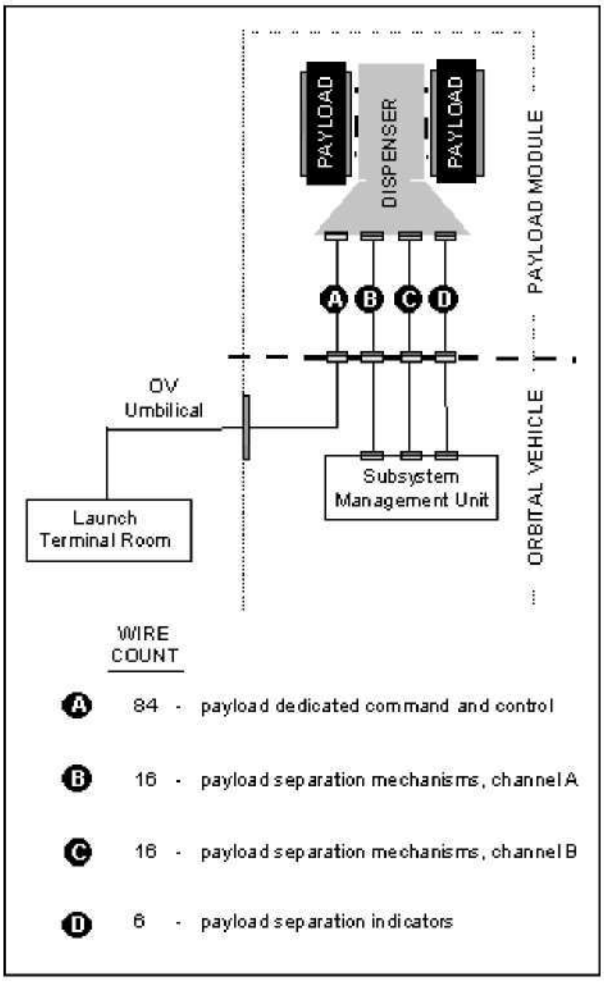


Figure 5-3. OV and Payload/Dispenser Electrical Interfaces

6. PAYLOAD ENVIRONMENTS

This section describes the payload environments induced by the K-1 and ground systems during prelaunch and flight.

6.1 Pre-Launch Environments

6.1.1 Payload Air Conditioning

Once the payload/dispenser is integrated into the payload module, conditioned purge gas is provided to maintain the temperature environment. This purge is maintained during all subsequent operations until launch.

Conditioned air or GN_2 is provided inside the payload module with a relative humidity set point between 30% and 60%. The nominal temperature within the payload module can be set between 10℃ and 24℃ (55℉ and 75℉) with a tolerance of plus or minus 2℃ (3.6℉). A backup gas condi tioning system is available in the event of a primary system failure.

The purge gas enters the payload module through a single OV umbilical. A manifold distributes the gas into the payload bay by two cooling ducts. The distribution system limits the gas velocity at the manifold exits to 1.5 m/s (5 ft/s). The gas can also be routed into the dispenser for direct payload thermal control. Payload module venting of the purge gas is accomplished by a passive flapper valve that opens into the OV forward skirt area.

6.1.2 Cleanliness/Contamination

The K-1 payload processing facility maintains a Class 100,000 clean environment in accordance with FED-STD-209. The payload is encapsulated in the K-1 payload module during transport between the payload processing facility (PPF), vehicle processing facility (VPF), and the launch stand. A positive purge pressure is maintained internal to the payload module to preclude entry of contaminants during the transport process. The purged gas is maintained at a Class 10,000 cleanliness level.

The materials and components used inside the K-1 payload module were carefully selected to meet the contamination requirements of payload customers. The K-1 Contamination Control Plan (CCP) docu-ments procedures for inspection and cleaning of all K-1 vehicle hardware and ground support equipment that comes into direct contact with the payload environment.

6.1.3 EMI and RF Environments

At the launch sites, the electromagnetic environment (EMI) to which the payload is exposed is generated primarily from the vehicle itself. The K-1 vehicle's TDRSS system is used for data uplink and downlink in the S-band at a total radiated power of approximately 5 watts. The electric field generated by the TDRSS system at the payload is estimated to be less than 3.4 V/m.

The K-1 also includes a U.S. Federal Aviation Administration (FAA) beacon. This device operates at 1060 ± 30 MHz. Analyses of generated electric fields indicate levels below 6.1 V/m at the payload.

There are no other sources of significant radio frequency (RF) environments. An RF hazard analysis is performed for each mission to verify that the customer's payload transmitters are compatible with vehicle avionics systems.

6.1.4 Electrostatic Potential

The dispenser provides a single point electrical ground for the payload. This single point ground is electrically common to the vehicle's single point ground. The electrical resistance of the payload-to-dispenser interface is 0.010 ohms or less and is verified during payload integration operations. Electrostatic grounding provisions are provided during all phases of payload integration and launch operations.

6.2 Flight Environments

This section contains predicted K-1 flight environ-ments. These levels will be verified during the flight test program. During operations, payload module acceleration, acoustic, temperature, and pressure data are recorded and provided to the customer.

6.2.1 Steady-State Acceleration

The maximum steady state axial K-1 acceleration occurs at the end of the OV main engine burn. Figure 6-1 shows a plot of maximum steady state axial acceleration as a function of payload weight. The OV main engine is throttled during the last part of the burn to limit the acceleration.

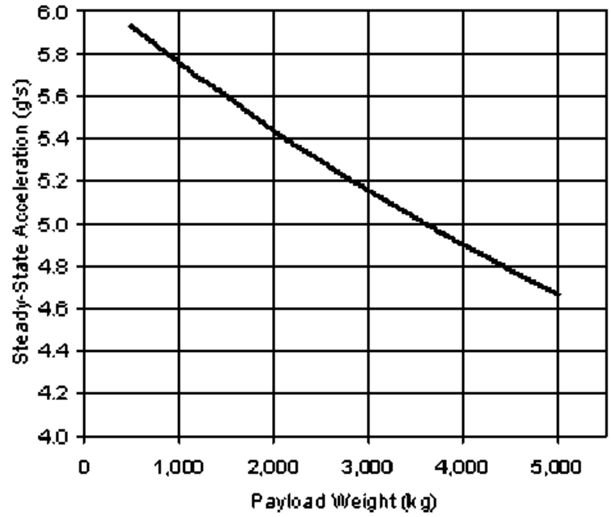


Figure 6-1. Maximum Axial Acceleration

6.2.2 Combined Loads

Dynamic loading inputs during liftoff, transonic, maximum dynamic pressure, separation, and main engine cutoff flight regimes are combined with the steady state accelerations to produce the combined loading environments experienced by the payload. The final payload accelerations are a function of the payload and dispenser stiffness characteristics. Recommended payload stiffness levels are 25 Hz axial and 10 Hz lateral. Secondary structure mode frequencies above 35 Hz are recommended to prevent coupling with K-1 modes. For payloads meeting these criteria, the design limit load factors of Table 6-1 apply. For payloads outside these levels, the results of the dynamic coupled loads analyses are used to provide a better definition of the loading environment.

Table 6-1. Design Limit Load Factors

	Limit Load Factors	
Load Case	Axial(1)	Lateral
Ground transportation on K-1	± 1.0	0/-2.0
Liftoff	+1.8	± 0.5
Maximum axial dynamic load @ OV MECO	+6.6/-2.2(2)	± 1.0
Maximum transverse load during flight	+2.0	± 2.0
Stage separation	+1.5	± 0.2
(1) + Compression, - Tension		
(2) The OV MECO dynamic axial load factor is 1.0g higher than the maximum static acceleration of Figure 6-1. The 6.6g value is based on a payload weight of 1,500 kg.		

6.2.3 Acoustic Environment

The maximum payload acoustic environment for the K-1 occurs during liftoff. The duration of exposure is less than 10 seconds. Typical levels for the K-1 extended payload module are shown in Figure 6-2 for an equivalent cross-sectional fill area of 50%, corresponding to an equivalent payload diameter of 2371 mm (93 in). This environment was predicted for the Woomera Spaceport launch site. Environments at the Nevada launch site are expected to be approximately 2 dB lower due to the higher altitude. Mission-specific acoustic analyses are performed to predict the environment given the size, shape, and overall dimensions of the customer's payload.

6.2.4 Vibration Environment

Random vibration levels for the payload/dispenser attachment interface are shown in Figure 6-3. The random vibration levels bound expected sinusoidal vibration levels induced during ascent.

1/3 Octave Band Center Frequency (Hz)	Sound Pressure Level (dB)
20	124
25	125
31.5	126.5
40	128
50	128
62.5	127
80	128.5
100	128.5
125	128
160	127.5
200	125.7
250	124.9
315	124
400	122
500	120
630	118.5
800	118
1000	117
1250	116
1600	115.5
2000	115
2500	114
3200	113
4000	112.5
5000	111
6400	109.5
8000	108

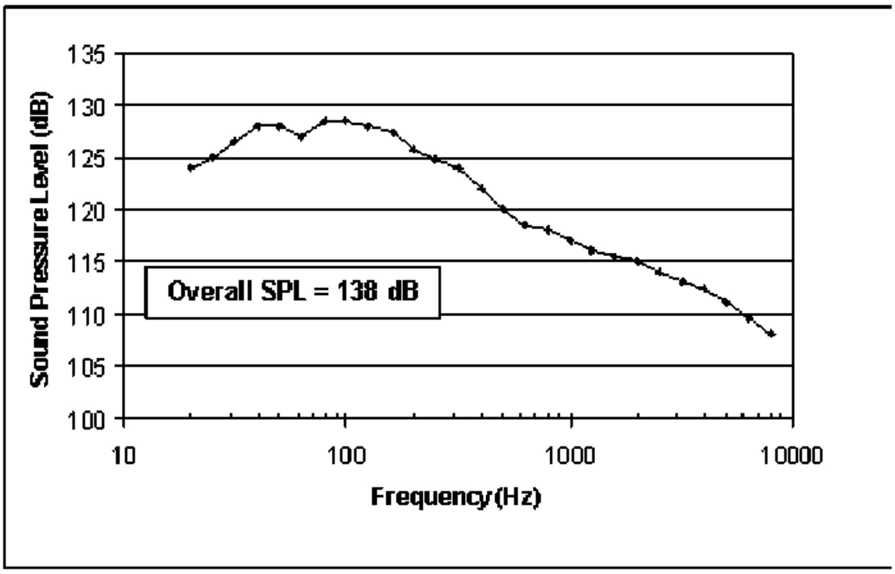


Figure 6-2. Acoustic Environment (1/3 Octave Band Level)

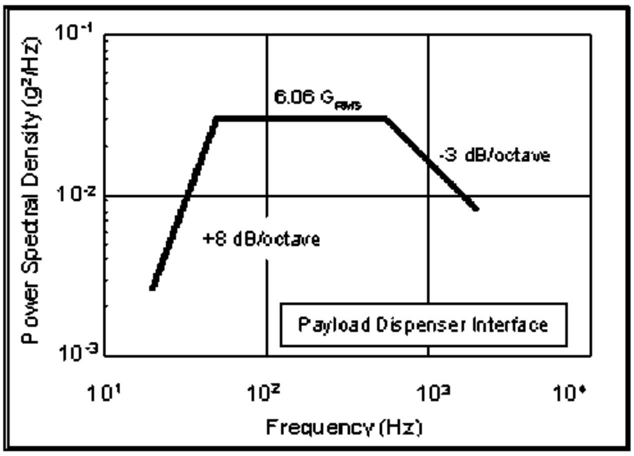


Figure 6-3. Random Vibration

6.2.5 Shock Loads

The maximum shock environment occurs at the payload/dispenser interface during payload separation from the K-1 vehicle. This environment is a function of the separation system configuration. The induced shock environment for a typical clampband payload separation system at the payload/dispenser interface is shown in Figure 6-4. A mission-specific shock analysis will be performed for each payload/dispenser configuration prior to the payload's first flight on the K-1 vehicle. The results of this analysis will be verified by a payload separation test, as described in Section 6.3.5.

6.2.6 Thermal Environment

Figure 6-5 shows the inner fairing surface temperature profile for a typical mission during ascent. Since the K-1 payload module remains closed until payload deployment there is no free molecular heating on the payload.

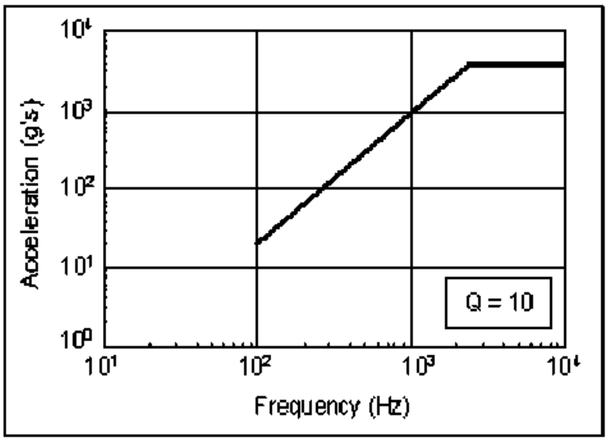


Figure 6-4. Shock Environment

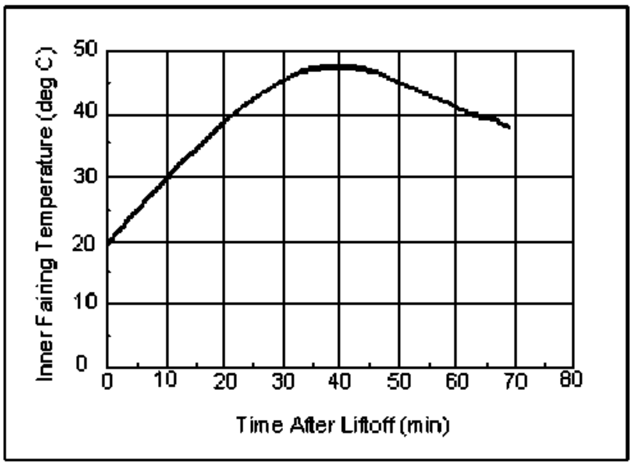


Figure 6-5. PM Inner Surface Temperature

6.2.7 Pressure Decay

During ascent, the payload compartment vents into the forward region of the OV. Valves in the base of the payload module provide the vent path. The maximum pressure decay rate profile is shown in Figure 6-6 for a launch from Woomera, Australia. The peak decay rate of –3.7 kPa/sec (0.54 psi/sec) occurs for approximately 5 seconds.

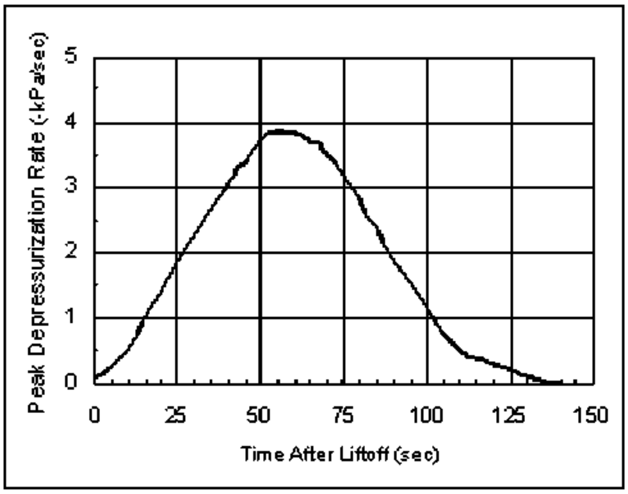


Figure 6-6. Depressurization Rate During Ascent

6.2.8 Cleanliness/Contamination

The design of the K-1 payload module, payload separation system, and cold gas attitude control system contributes to a contamination-free flight environment for the payload. The payload module is designed to limit the maximum level of payload contaminants to 20 mg/m^2 molecular and Level 750 particulate, in accordance with MIL-STD-1246.

6.3 Payload Design and Verification Requirements

This section provides requirements guidelines for design and environmental testing of payloads intended for flight on the K-1 vehicle. Specific requirements will be mutually developed by the customer and the K-1 Program Office.

6.3.1 Factors of Safety

The limit load factors for flight are given in Table 6-1. Ultimate load factors are obtained by multiplication of the limit load factors by the factors of safety listed in Table 6-2. The payload must be capable of sustaining the loading cases derived from the ultimate load factors. The "test" factors apply to a payload that will be verified by a static load test. If the payload primary structure is to be demonstrated by analysis, the "no test" factors of safety shall be applied for design.

Table 6-2. Payload Design Factors of Safety

Description	Test	No Test
Yield	1.05	1.60
Ultimate	1.33	2.00

6.3.2 Structural Load Tests

Static load testing is performed by the customer to demonstrate the design integrity of the payload primary structural elements. For payload structures designed to the lower factor of safety levels of Table 6-2, the maximum limit load factors given in Table 6-1 are to be multiplied by 1.25 and 1.10 to determine the qualification and acceptance static test loads, respectively.

6.3.3 Acoustic Testing

Payload acoustic testing is required to assess both the workmanship of the payload structure and the adequacy of component random vibration design and test levels. The spectrum of sound pressure levels to be used as a test specification is provided in Figure 6-2.

The acoustic margins and duration for qualification, proto-flight, and acceptance testing are defined Table 6-3.

Table 6-3. Payload Acoustic Test Margins and Durations

Test	Margin	Duration
Qualification	+ 3dB over acceptance	120 sec, each axis
Proto-flight	+ 3dB over acceptance	60 sec, each axis
Acceptance	Max. expected acoustic levels per para. 6.2.4	60 sec, each axis

6.3.4 Vibration Test

The acceleration power spectral density to be used as a test specification is provided in Figure 6-2. This spectrum should be applied in all three axes. The random vibration margins and duration for qualification, proto-flight, and acceptance testing are defined in Table 6-4.

The random vibration test specification is expected to be the best simulation of the flight environments. For certain payloads or unique circumstances, a sinusoidal vibration test may be the best approach for qualification and acceptance testing. In this case, the K-1 Program Office will provide a sinusoidal vibration test specification.

Table 6-4. Payload Random Vibration Test Margins and Durations

Test	Margin	Duration
Qualification	+ 3dB over acceptance	60 sec
Proto-flight	+ 3dB over acceptance	20 sec
Acceptance	Flight levels per para. 6.2.5	20 sec

6.3.5 Fit Check, Separation, and Shock Test

A fit check is performed to verify critical interfaces between the payload and flight dispenser at the payload manufacturing facility. Matchmate tools that duplicate critical interfaces between Kistler and customer hardware will be used during the manufacturing processes to assure satisfactory fit check results.

A separation and shock test will verify separation performance and shock loads by deploying a simulated payload from a dispenser. These tests are typically performed at the dispenser manufacturing facility in cooperation with the customer. The simulated payload and any payload support equipment are provided by the customer.

7. MISSION MANAGEMENT

7.1 Organization

Kistler assigns a dedicated Mission Manager at contract go-ahead to lead the mission organization shown in Figure 7-1. This manager will be the single point of contact for the customer and will have full program management authority and responsibility.

The Kistler Engineering organization is responsible for all mission analyses and integration efforts. If Kistler is to develop and qualify the dispenser, the Engineering organization will also conduct this effort.

The Launch Operations organization is responsible for operations planning, launch site payload integration, K-1 vehicle maintenance and checkout, coordination of facility requirements, and daily management of launch site activities. For Australian launches, Kistler Woomera Pty. Ltd. performs this roll under general supervision of Kistler Aerospace.

The Engineering and Launch Operations organ-izations work closely with the customer to plan and implement the launch campaign.

Contract Administration, Quality Assurance, and Regulatory Affairs personnel are also key members of the mission organization.

7.2 Mission Scheduling

Figure 7-2 shows a representative mission schedule. Faster response times of 30 days or less from call-up can be supported if the dispenser is available and an initial set of mission analyses is complete.

7.3 Meetings and Reviews

A series of meetings and reviews support coordination between Kistler, the customer, and other participating organizations. These are agreed upon with the customer at the start of the program. A typical schedule of program meetings and reviews is given in Table 7-1.

7.4 Payload Integration

This section describes the payload integration process, the documentation used, and the analyses performed to support a mission. This approach can be tailored to meet the specific requirements of the customer.

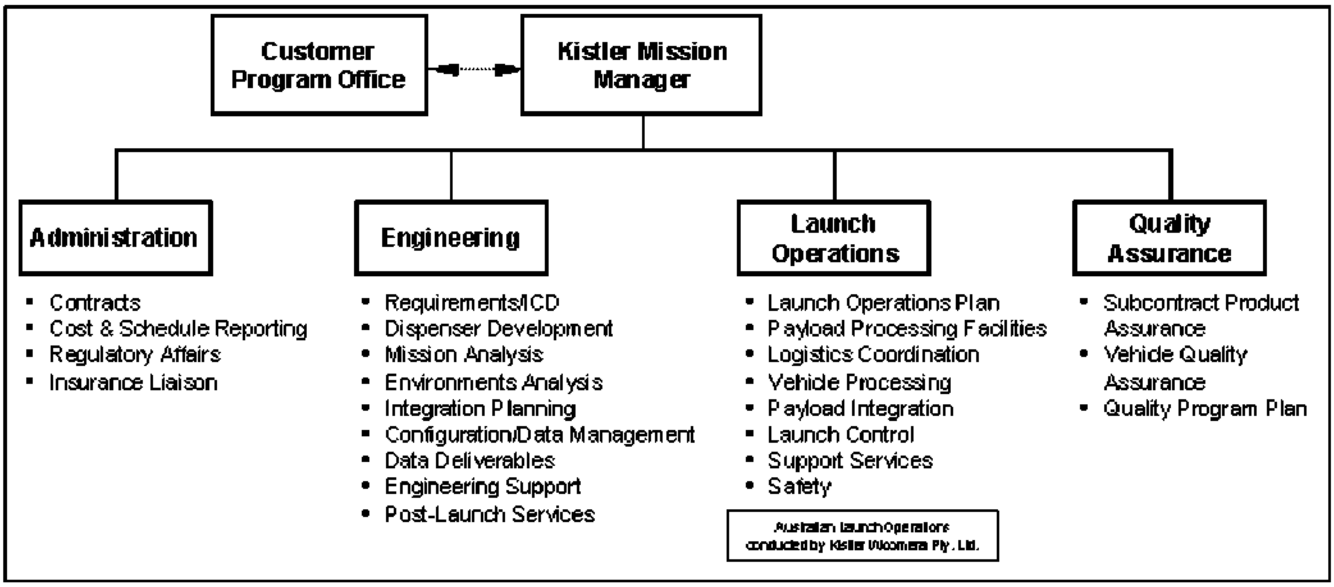


Figure 7-1. Mission Management Organization

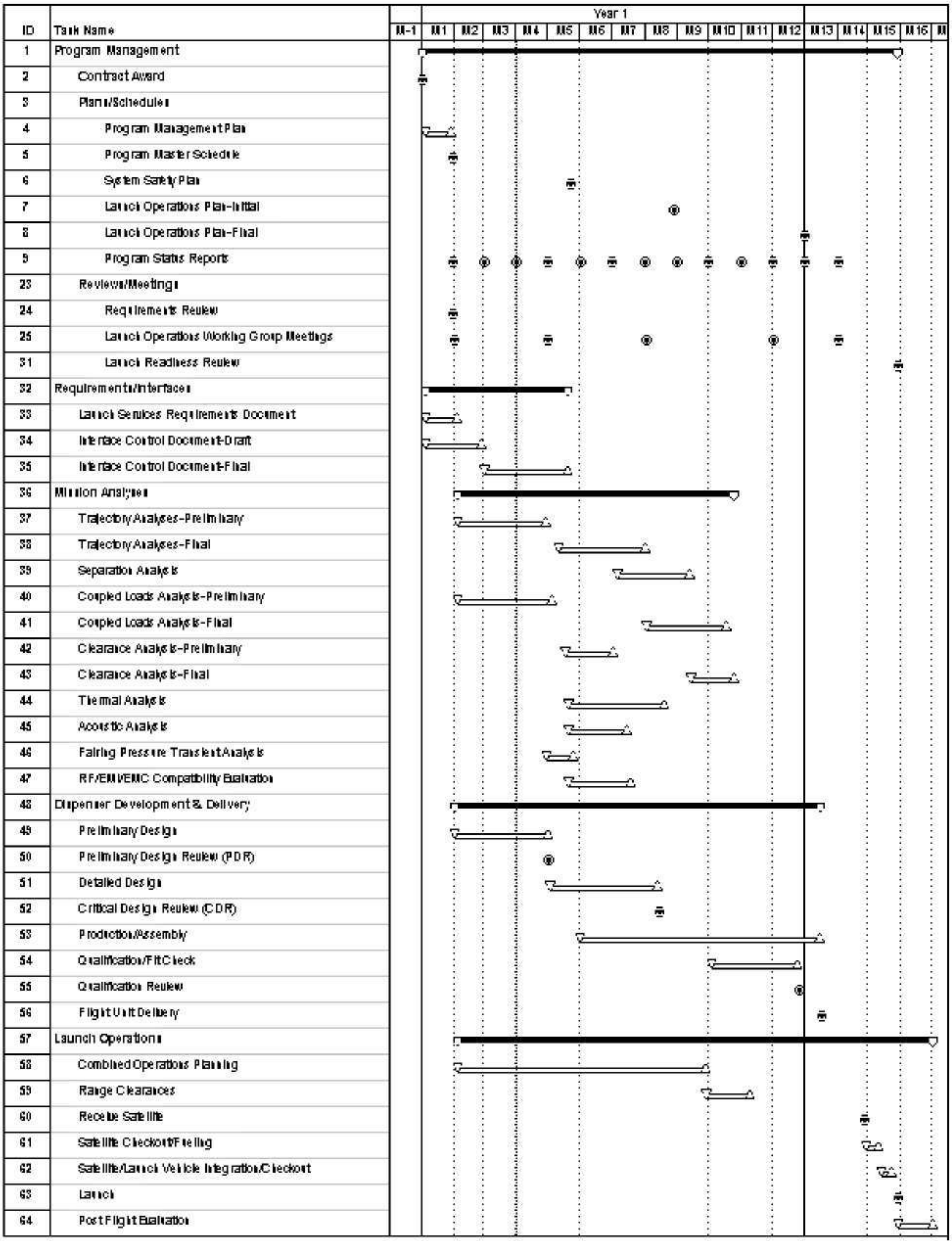


Figure 7-2. Typical Mission Schedule

7.4.1 Integration Process

The objective of the mission integration process is to develop and manage all payload-to-vehicle requirements and interfaces to ensure successful payload deployment. The integration process starts at contract award and continues through post-flight evaluation.

Kistler is responsible for planning and implementing all integration activities through close coordination with the customer. Kistler is also responsible for the development and control of key documentation and ensuring effective communications between all parties.

7.4.2 Documentation

Three primary documents are used to assure effective integration of the payload into the K-1 launch system. Kistler and the customer will jointly develop these documents. Figure 7-3 shows the relationships between these documents. Other mission unique documents can be developed as required.

Table 7-1. Program Meetings and Reviews

Meeting	Description	Schedule	Location
Requirements review	Review/approve Launch Services Requirement Document (LSRD)	L-14 mos	Customer
Launch operations working group meetings	Coordinate all requirements, interfaces, and operations issues, signoff on Interface Control Document (ICD), update Launch Operations Plan (LOP)	Every 3 months	Alternate between Customer and Kistler
Interface review	Initial release of Interface Control Document (ICD)	L-13 mos	Customer
Dispenser PDR (if required)	Review preliminary dispenser design	L-13 mos	Dispenser Contractor
Dispenser CDR (if required)	Review final dispenser design, approve for final manufacturing	L-8 mos	Dispenser Contractor
Site survey	Survey launch site facilities, review operations procedures	L-6 mos	Launch Site
Dispenser qual. test review (if required)	Review/approve results of dispenser qualification tests	L-4 mos	Dispenser Contractor
Mission analysis review	Review results of all mission specific analysis	L-4 mos	Kistler
Launch operations readiness review	Review/approve final LOP, verify all plans, procedures, and logistics are in place to begin launch operations	L-2 mos	Launch Site
Launch readiness review	Verify ready to launch	L-1 day	Launch Site

Launch Services Requirements Document. The LSRD is the primary requirements document for the program. It defines the requirements for physical, functional, and environmental interfaces, mission design and performance, integrated ground operations, verification, and safety. Kistler and the customer will prepare a draft of the LSRD at contract go-ahead. The initial release of the LSRD occurs early in the program and it is maintained under configuration control by the customer.

The LSRD is the primary requirements document for the program. It defines the requirements for physical, functional, and environmental interfaces, mission design and performance, integrated ground operations, verification, and safety. Kistler and the customer will prepare a draft of the LSRD at contract go-ahead. The initial release of the LSRD occurs early in the program and it is maintained under configuration control by the customer.

Interface Control Document. The program ICD is developed jointly by Kistler and the customer and used to document all aspects of the mission-specific payload to launch system interface. The ICD includes the payload description, specific mission requirements, launch vehicle description, payload interface requirements, and interface drawings. Table 7-2 lists typical information contained in the ICD.

The initial release of the ICD will occur soon after contract award. Configuration control is maintained by Kistler. It will be updated as data become available.

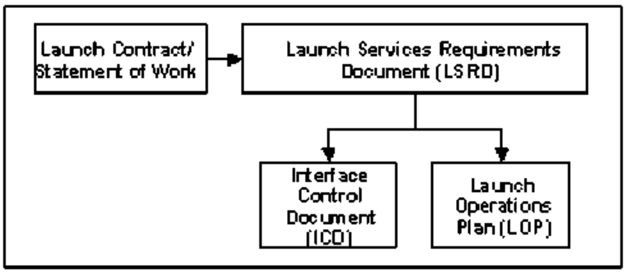


Figure 7-3. K-1 Launch Services Requirements Flow

Launch Operations Plan. The LOP defines all aspects of the launch campaign. For a typical
mission, the initial LOP is released approximately 12 months before launch and updated by Kistler as requirements and plans mature. Table 7-3 identifies the information contained in the LOP.

Mission Analyses Reports. Specific mission analyses will be performed to assure flight requirements are met and to generate the mission data load. As a minimum, these analyses address coupled loads, thermal conditions, EMI/EMC environments, RF compatibility, contamination, trajectory, clearance, separation, and post-separation collision avoidance. Analysis reports are submitted to the customer.

Table 7-2. Interface Control Document (ICD)

Requirement	Interface Data Item	Provided By
Mission objectives		Customer
Payload characteristics	Reference coordinates	Customer
	Mass properties	Customer
	Static envelope/volume	Customer
	Hazardous systems	Customer
	RF systems	Customer
	Contamination sensitive regions	Customer
Mission requirements	Orbital criteria	Customer
	Key payload events	Customer
	Launch site	Customer
	Launch windows	Customer
	General description	Kistler
Launch vehicle description	Reference coordinates	Kistler
	Mission specific characteristics	Kistler/Customer

Interface requirements	Structural stiffness and loads	Kistler/Customer
	Dynamic environment	Kistler
	Payload mass model and stiffness	Customer
	Thermal environment	Kistler/Customer
Interface drawings	Payload interface	Customer
	Payload to dispenser – mechanical	Kistler
	Payload to dispenser - electrical	Kistler
	Launch site/payload/GSE electrical	Kistler/Customer

Table 7-3. Launch Operations Plan (LOP)

Data Item	Description
General operations requirements	Operations organization and general requirements
Combined operations	Operational roles and responsibilities of joint Kistler/Customer launch team
Office areas	Describe available office space and utilization
Transportation & storage	Transportation responsibilities, plans, and storage accommodations
Payload processing areas	Payload processing flow, including receiving, electrical checkout, propulsion system tests, support requirements, and timeline
Fueling areas	Payload fueling process flow, fueling procedures, fueling equipment, weighing requirements, support requirements, timeline, and responsibilities
Dispenser integration areas	Dispenser processing flow, spacecraft integration, system interfaces, dispenser harness validation, timeline, and responsibilities
Payload module integration	Process and procedures to integrate the payload to payload module in PPF, and payload module to the OV in the VPF, includes definition of spacecraft monitoring and environmental control
Vehicle harness test & checkout	Procedures to verify end-to-end harness integrity prior to roll-out to the pad
Launch pad umbilical test & checkout	Procedures to verify end-to-end harness integrity once vehicle is connected to launch pad umbilicals
Launch commit process	Launch commit procedures and responsibilities for combined operations team
Communications	Communications equipment, procedures, and responsibilities
Medical	Medical services, emergency plans
Security	Security system and procedures
Safety	Safety plan, training, and procedures

8. LAUNCH OPERATIONS

8.1 Launch Site Overview

Kistler is establishing two launch sites for operation of the fleet of K-1 reusable aerospace vehicles. Spaceport Woomera is located in Woomera, South Australia, about 470 km (280 miles) north of Adelaide. Spaceport Nevada is located at the Nevada Test Site, near Las Vegas, Nevada, USA. The locations of these sites are shown in Figures 8-1 and 8-2. The initial launch corridors are indicated. The launch sites will have nearly identical facilities, infrastructure, and support equipment. Test flights and initial commercial operations will be conducted from Spaceport Woomera.

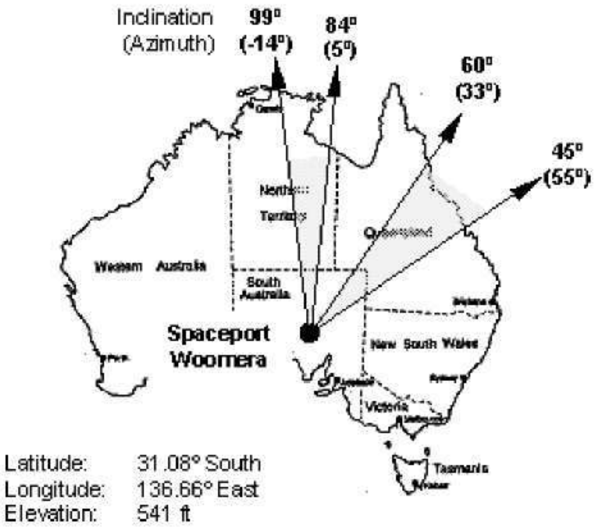


Figure 8-1. Australia Launch Site

Both launch sites provide efficient payload processing, integration, and launch operations. The payloads are received, checked out, fueled, and integrated with the payload module in the Payload Processing Facility (PPF). Once encapsulation is complete, the payload module is moved to the Vehicle Processing Facility (VPF) for final horizontal integration with the OV and LAP stages. After final checkout procedures are complete in the VPF, the K-1 vehicle is rolled out to the launch pad, erected, fueled, and launched. Figure 8-3 provides an overview of Spaceport Woomera.

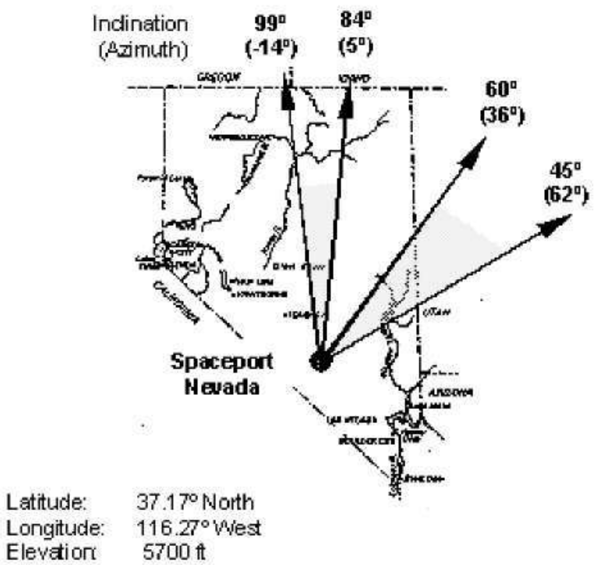


Figure 8-2. Nevada Launch Site

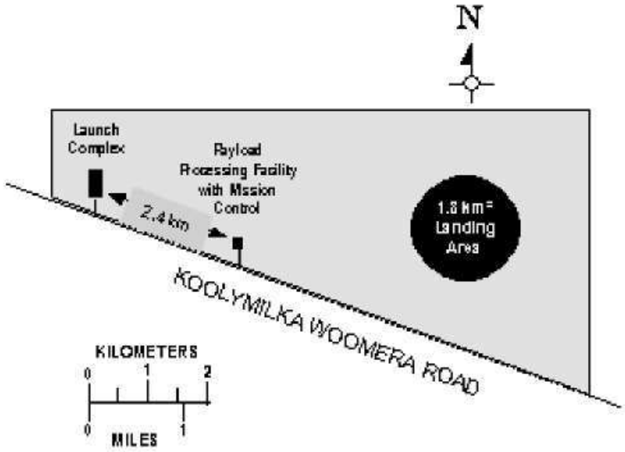


Figure 8-3. Spaceport Woomera Overview

8.2 Payload Processing Facility

Figure 8-4 shows a layout of the initial Kistler PPF. It includes two highbay payload processing work areas, two processing control rooms, a highbay payload module processing and hazardous operations area, a master airlock, a support equipment storage area, and the necessary office and personnel facilities. The Kistler mission control center is also located in the PPF. All processing facilities are maintained at a Class 100,000 cleanliness level. Environmental conditions are controlled within 24 ± 2.8°C (75 ± 5°F) and 50 ± 5% relative humidity.

Highbay Work Area. The highbay work area has access to a 10-meter (33-ft) overhead crane that can accommodate loads up to 7,500 kg (16,500 lbm). There are two 7.5 m x 10 m (25 ft x 33 ft) work areas, separated by retractable doors. Cleanroom tugs move the payload module and payload. Nitrogen and helium are supplied to the highbay and payload fueling areas at 15,200 kPa (2200 psi). Facility power is provided at 50 Hz at 415 V and is regulated down to 50 Hz at 220 V and 120 V system requirements.

Hazardous Processing Area. The HPA is an integral part of the PPF. It is used initially for payload module maintenance. Once the payload is ready for fueling, it is moved into the HPA. Final integration with the dispenser and the payload module also occurs in this facility. The HPA includes facilities to remove and contain any toxic wastes from fueling operations. Kistler can supply propellants under contract.

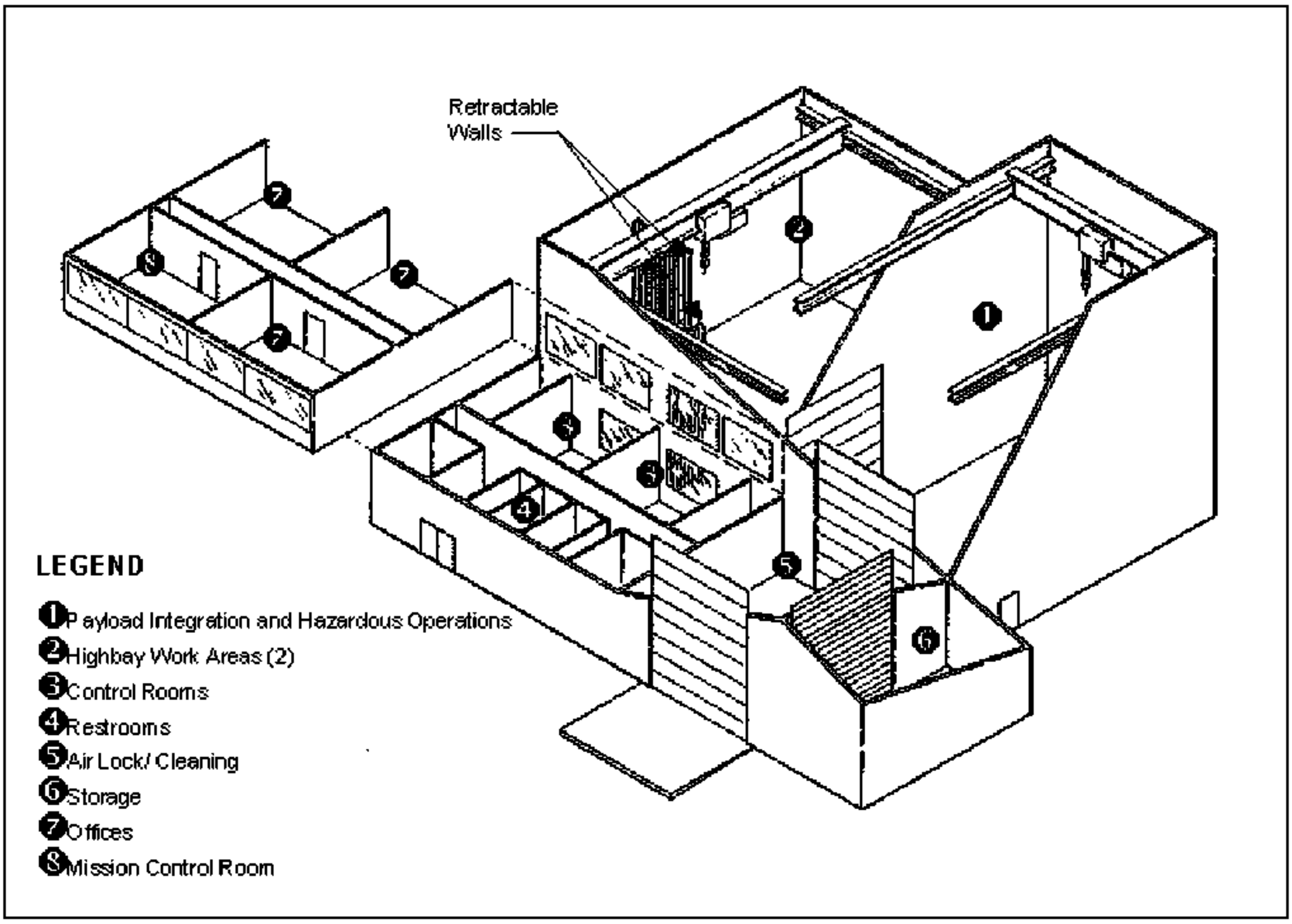


Figure 8-4. Payload Processing Facility (PPF)

Control Rooms. The highbay has two dedicated payload processing control rooms for customer use. A large door is provided in each control room to facilitate installation of customer support equipment. Each control room has a large window for viewing activities in the highbay areas and is also linked to a closed-circuit TV system.

The control rooms also serve as the center for customer on-pad payload operations. Fiber optic control lines lead from the PPF to the terminal room at the pad for remote control of customer GSE during launch operations. The control rooms have direct communications to the mission control room, located in the same building for pre-launch coordination.

Office Space. Office accommodations are provided for payload project personnel. This space is conveniently located above the control rooms and has windows to view activities in the highbay.

Communications. The PPF is equipped with closed circuit TV, and audio and video recorders to document and archive daily activities. Local and international telephone and T1 connections are available.

Payload Storage. Secure storage facility is provided for payloads, dispensers and shipping containers.

Storage Magazines. Concrete bunker-type storage magazines are available for storing ordnance, payload fuels or other hazardous materials.

8.3 Launch Complex.

The K-1 launch complex includes the launch stand and erector, the VPF, and various propellant storage tanks. Figure 8-5 provides an overview of the complex.

Vehicle Processing Facility. This facility is used for maintenance activities for each stage, checkout of all vehicle systems, and integration of the LAP, OV, and payload module.

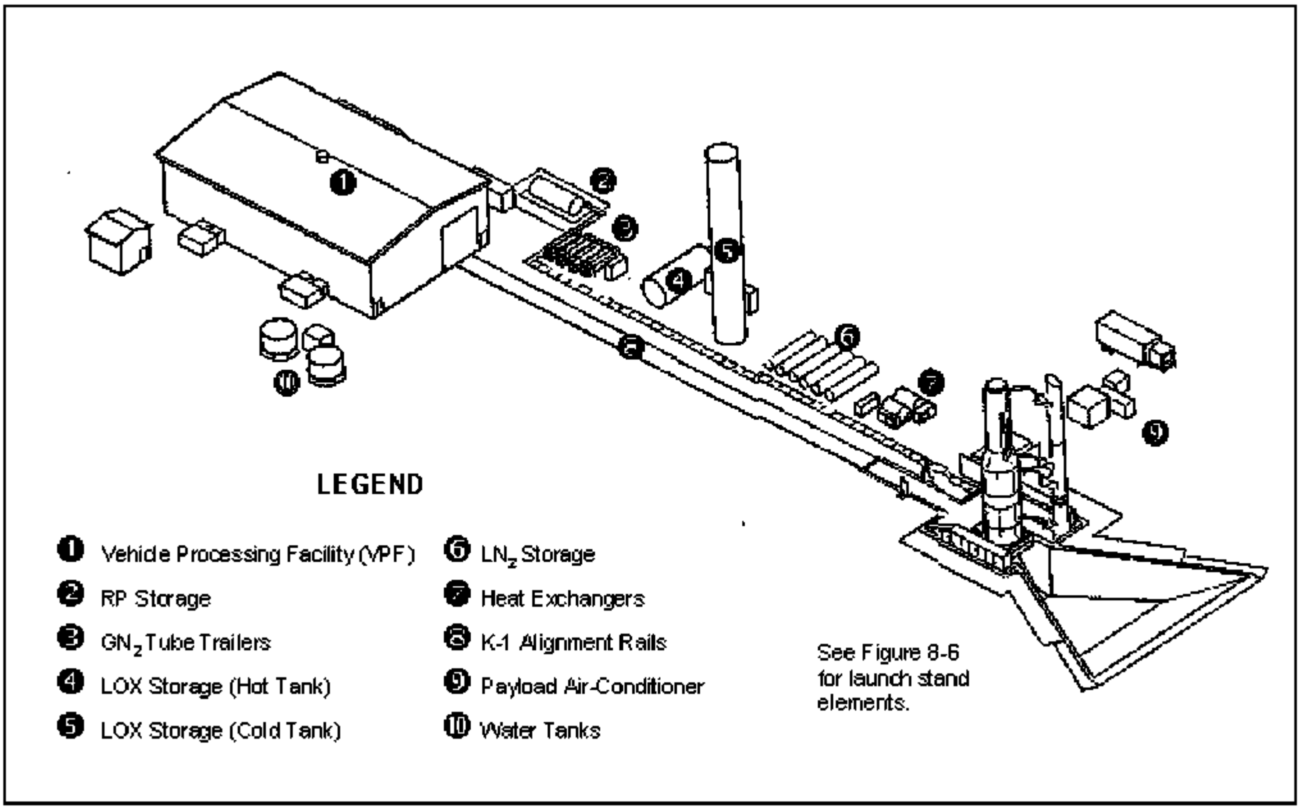


Figure 8-5. K-1 Launch Complex Overview

Terminal Room. The terminal room is located near the launch stand. This facility accommodates electrical interfaces between the mission control room in the PPF and the umbilical mast at the launch stand. Monitoring and control of customer payload GSE is provided through modems to Seimens WCH-08p fiber optic transmitters. Forty-two (42) twisted and shielded pairs of 16 AGW wires run 53m (174 feet) between the terminal room junction box and the OV payload umbilical interface. Electrical power includes 50 Hz, 415 volt, 30 amp three-phase and 50 Hz, 250 volt, 60 amp single-phase. Six standard equipment racks are allocated for customer GSE.

Launch Stand and Erector. The K-1 launch stand, shown in Figure 8-6 is located 150 m (490 ft) from the VPF. A rail system is used to transport the vehicle from the VPF to the launch stand.

Once at the stand, final connections are made to the four flyaway umbilicals and the erector is used to move the vehicle to an upright position on the launch ring. Fueling operations are completed in 4 hours while final functional checks are performed. The entire process from VPF rollout to launch takes less than 6 hours. No loss of air conditioning, power or communication with the payload will occur as a result of an on-pad abort.

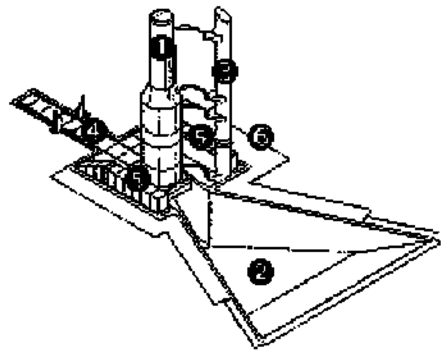


Figure 8-6. Launch Stand Elements

A support equipment cart provides redundant payload environmental conditioning and power supply during all payload module transportation and mated vehicle operations.

8.4 Support Services

Transportation. The Woomera airport can accommodate large aircraft, including the US Air Force C5A, Boeing 747, and Russian AN 124. Kistler will provide handling equipment and transportation to move the payload and customer GSE the 11 km (7 miles) from the Woomera airport to the PPF. Kistler can help arrange additional transportation services as required. In Australia, logistics activities are arranged by Kistler's wholly-owned subsidiary, Spaceport Woomera Pty. Ltd.

Communications. The communications network at the Kistler Woomera launch complex is designed to support video, voice, and data needs, both locally and off-site.

A closed-circuit video system is provided at the PPF and launch stand. Fiber optic lines run between the PPF and launch stand to support high bandwidth transmission of data.

Security. Spaceport Woomera lies within the restricted Woomera Prohibited Area (WPA), operated by the Australian Government. The WPA authorities must authorize by name all personnel entering the WPA. This provides the first level of security.

A Kistler Woomera guard station has been established on Koolymilka Road, the only road access to the launch complex. Access to the launch site is controlled by this checkpoint.

There are established guard posts inside the VPF and PPF to control personnel and equipment entering these facilities. Inside the PPF, coded cipher locks are used to control access to key areas

Woomera Accommodations. The community of Woomera provides a range of housing, meal, medical, and recreation services. Table 8-1 describes these accommodations.

Table 8-1. Woomera Accommodations

Customer Requirement	Woomera Accommodations*	Remarks
Commercial Airline Service to Woomera, SA	• Airlines of South Australia (ASA) flights from Adelaide	Reservations through Qantas Airlines. ASA will fly extra flights at Kistler request for heavy traffic times.
Long-term personnel housing (3 months or more)	• 3-bedroom houses • 1, 2 and 3-bedroom apartments	Kistler leases fixed block of houses and apartments. Availability varies.
Short-term personnel housing (daily, weekly)	• ELDO Hotel, Woomera • Temporary apartments (limited to less than 90 days occupancy)	Direct reservations by customer recommended. ELDO Hotel: phone + 61-8-8673-7867. Temporary apartments: phone + 61-8-8674-3200.
Transportation	• Dasfleet garage (National Car Rental agency) located in the Woomera Prohibited Area.	Kistler leases a fleet of Dasfleet cars/vans for travel to launch site. Customer can rent cars directly for short-term local use, if desired. Dasfleet phone: + 61-8-8673-7955 (will meet customers at airport).
Meal service	• ELDO Hotel restaurant • Woomera Snack Bar • Oasis Club Restaurant • Sports Club (Italian) • RSA Bowls Club (Mexican)	Commercial meal service available as noted. Lunch room vending machines available at launch site. The ELDO Hotel will cater or provide box lunches, if requested.
Medical service	• Woomera Hospital • Emergency Response Service	All emergency medical services available to non-Australian personnel in the Woomera Prohibited Area.
Local recreation	• Woomera facilities include public swimming pool, ten-pin and lawn bowls, movie theater, golf course, rocket museum, athletic field, tennis courts, casino and various clubs.	All facilities are open to residents and visitors. Most are available without cost; others require a small charge. The local 4WD Club organizes weekend "convoy" excursions into the Outback.
Holiday recreation	• Frequent bus and train tours organized through the Oasis Club. • ASA flights to Adelaide.	Popular locations include Adelaide (shopping, casino, sports, entertainment, etc.), Alice Springs area (Ayers Rock, Kings' Canyon, Devil's Marbles, etc.), Kangaroo Island (wildlife), Coober Pedy and Andamooka (Opal mines), Darwin, Sydney, Perth and other

* Available, but not provided, community services near Kistler launch site at Woomera, South Australia.

8.5 Launch Process Flow

Launch operations for the K-1 vehicles involve five activities: preparation of the recovered stages for the next flight; preparation of the payload for launch; integration of the payload with the vehicle; vehicle rollout and erection at the pad; and pre-launch fueling and checkout. Figure 8-7 shows the payload integration process with the K-1 payload module. Figure 8-8 shows the overall launch process flow.

The K-1 vehicle is designed to support a 9-day turnaround from landing to next launch. During this time, each stage is returned to the VPF, vehicle health maintenance (VHM) data are downloaded from the vehicle, maintenance activities are scheduled and completed based on the VHM data, and final test and checkout activities conducted. The payload module is removed and transported to the PPF for payload integration.

In parallel, the payload is received at the payload processing facility. Once the payload functional tests are performed and fueling is complete, a combined Kistler/customer team integrates the payload with the dispenser and the payload module.

The payload module is then transported to the VPF for final integration with the OV. The mated K-1 vehicle is then transported to the launch site, erected, fueled, and prepared for launch.

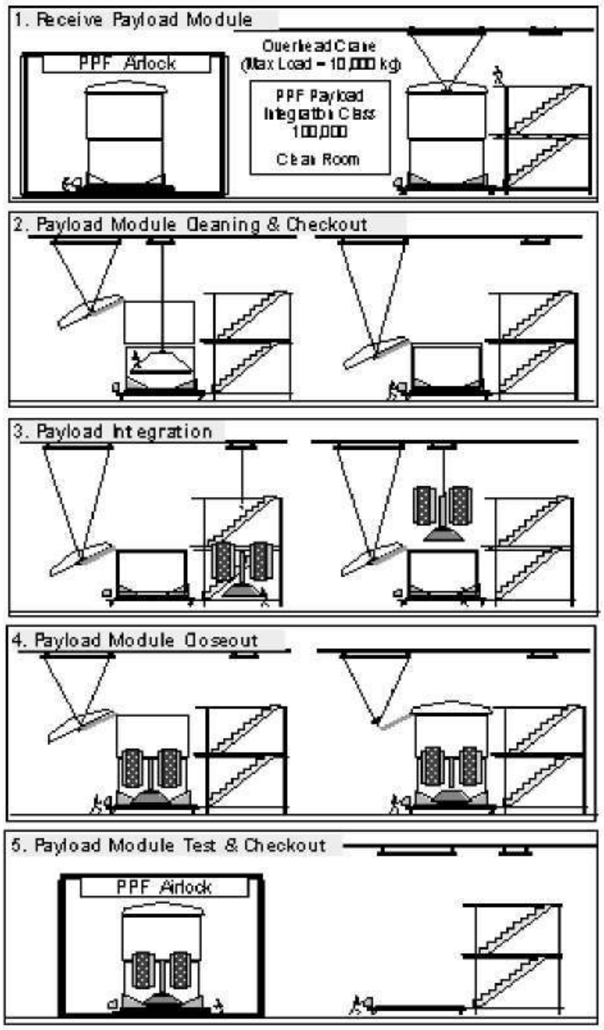


Figure 8-7. Payload Integration Flow

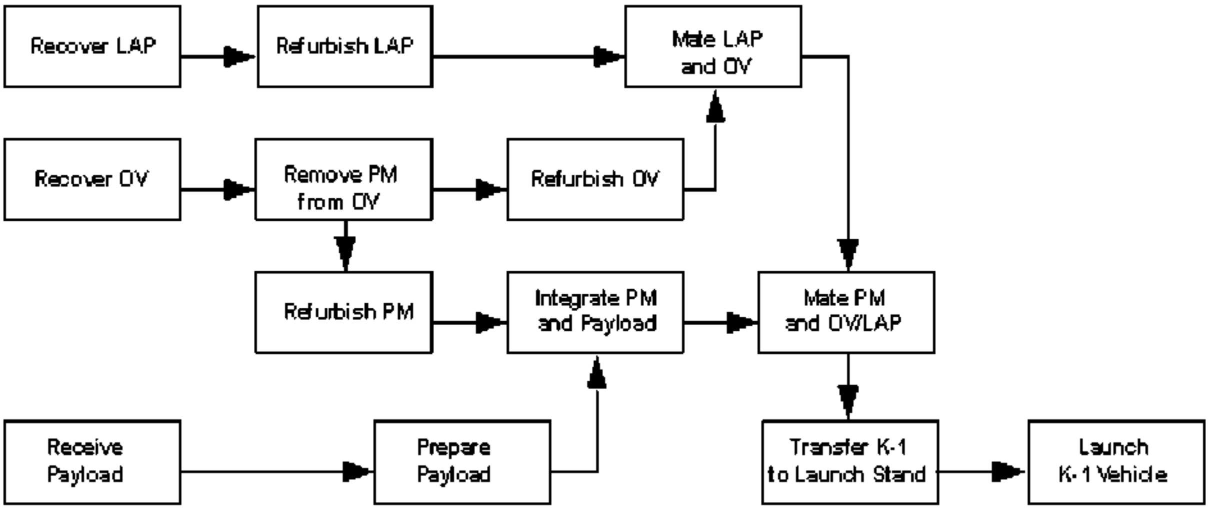


Figure 8-8. Launch Process Flow

8.6 Launch Process Flow

The launch decision process involves the appropriate management personnel from Kistler and the customer. Figure 8-9 shows the launch decision relationships.

Once the customer's launch schedule is defined, Kistler Woomera coordinates with local agencies to acquire launch day clearances.

The Director of Flight Operations (DFO) conducts a Launch Readiness Review (LRR) 24 hours before launch to verify that vehicle and payload systems are ready for launch.

The launch team is responsible for assessing launch day environmental conditions relative to the defined launch commit criteria.

The DFO, after consultation with the launch team, the customer Launch Director, and the Woomera Range Administrator, will make the final launch commit decision.

At 20 minutes prior to launch, the DFO authorizes initiation of final launch operations. After first stage ignition, the vehicle autonomously executes a self-check sequence at the 50% throttle setting during engine ramp-up. If all systems are performing acceptably, the engines complete throttle up and liftoff occurs.

8.7 Post-Launch Reports

Kistler provides two post-launch reports. The first Quick-Look Data Report will be provided within two days of the launch. This report includes preliminary trajectory performance data, orbital accuracy estimates, and an initial evaluation of overall system performance.

A detailed Post-Flight Evaluation Report will be provided to the payload customer within 4 weeks of the launch. This final report will include final trajectory performance data, major event timelines, environments and other significant data from on-board sensors and range tracking. Available photographic and video documentation will be included. The report will compare flight data and LSRD requirements to document mission success.

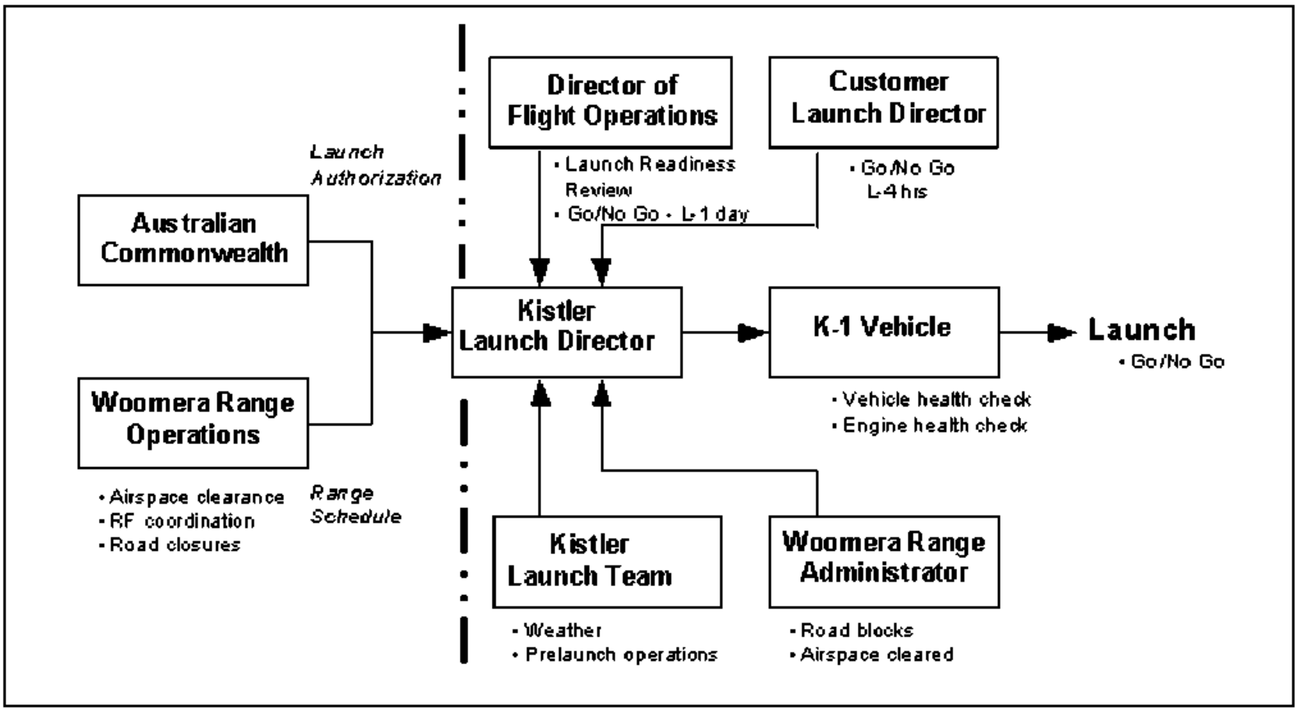


Figure 8-9. Launch Decision Relationships

8.8 Safety

In Australia, Kistler Woomera Pty. Ltd. is responsible for the safety of vehicle operations and compliance with applicable regulations. The Director of Quality and Safety is the focal point for coordination of all program safety efforts and implementation of requirements. Similar organizational and implementation responsibilities will be established at Spaceport Nevada.

Assuring safety during conduct of hazardous operations at Spaceport Woomera is the joint responsibility of Kistler and the customer. Full integration of payload unique procedures and customer personnel into the Kistler launch site operations is essential.

8.8.1 Personnel and Procedures

To ensure safety of personnel and equipment during payload preparation and subsequent launch operations, the customer is required to support development of payload unique procedures and training of on-site personnel. The customer will submit all hazardous payload processing procedures for review and approval by Kistler Woomera.

Customer personnel are to be skilled in processing operations on the payload and in operations performed at Kistler Woomera. Customer personnel will be provided safety training for operations and emergency procedures unique to the Woomera launch site facilities.

8.8.2 Payload and Support Equipment Design

The design of all customer payload and support equipment to be used at Spaceport Woomera shall be in accord with prudent industry practices that minimize safety risks.

Particular emphasis will be applied to mitigate launch site operational hazards related to pressurized systems. Customer data supporting the design and safe operation of payload pressurization systems shall be submitted to Kistler

Woomera for review. All pressure vessels and tanks at the launch site shall have a minimum 2-to-1 factor of safety. The factor of safety is defined as the ratio between the operating pressure and the design burst pressure.

8.8.3 Safety Approval Process

For the first launch of a payload, the safety approval process will follow a three-phase approach. Follow-on missions of the same payload will use an abbreviated version of this approach in which changes to the previously approved mission are identified.

Phase 1 – Hazard Identification. This phase includes the identification of all hazards associated with the payload design, processing, operations, and identification of means of controlling the hazards.

Phase 2 – Hazard Mitigation. In this phase the customer design, manufacturing, qualification and acceptance documentation will be reviewed to assure minimal safety risk during payload preparation and launch operations.

Phase 3 – Compliance Verification. During this phase, Kistler Woomera will assess customer documentation to verify compliance with K-1 safety requirements and applicable regulations.

During each phase, the data will be evaluated for completeness and actions taken to close open issues.

8.8.4 Meetings and Reviews

Progress of the safety approval process will be routinely addressed at Launch Operations Working Group meetings. Verification that all safety requirements have been satisfied will be a part of the Launch Readiness Review. Any open safety issues following this review will be recorded and final disposition completed and agreed to by mission management prior to proceeding with launch operations.