

8.0 Optional Services

Orbital offers a variety of optional services to satisfy the varied requirements of Taurus payloads. This section of the User's Guide details the optional services that are currently available to Taurus Customers. If a unique requirement exists that is not addressed within this section, please inquire directly to the Taurus Program Office to determine how best to meet the need.

8.1 Dual Manifest Options

The Taurus Program possesses significant experience in implementing dual-manifest configurations. Orbital provides two payload support structures that enable dual payload manifesting while maintaining independent load paths for the payloads. The 63" (1.6 m) diameter Dual Payload Adapter (DPA) was successfully flown on the second Taurus mission. The 50" (1.3 m) diameter DPA flew on the fourth and sixth Taurus missions.

8.1.1 63" DPA

A secondary payload configuration utilizing the qualified, flight-proven, 63" DPA is depicted in Figure 8-1. The 63" DPA is designed to maximize the larger volume of the 92" fairing configuration. The secondary payload is housed within the DPA structure and is deployed out of this structure following primary payload and forward payload cone separation. The advantage of this configuration is that the primary payload is completely isolated from the effects of the secondary payload. The DPA is a cylindrical graphite composite structure assembled to the base of the fairing adapter cone. The load path is carried through a forward conical structure, a cylindrical structure, and through the base of the fairing adapter cone structure. The height of the DPA can be adjusted (89" maximum) to tailor the height of the secondary payload volume as long as the envelope and environmental requirements for the primary payload are not violated. The envelope available for the secondary payload depends upon the primary payload characteristics and the separation dynamics of the secondary payload.

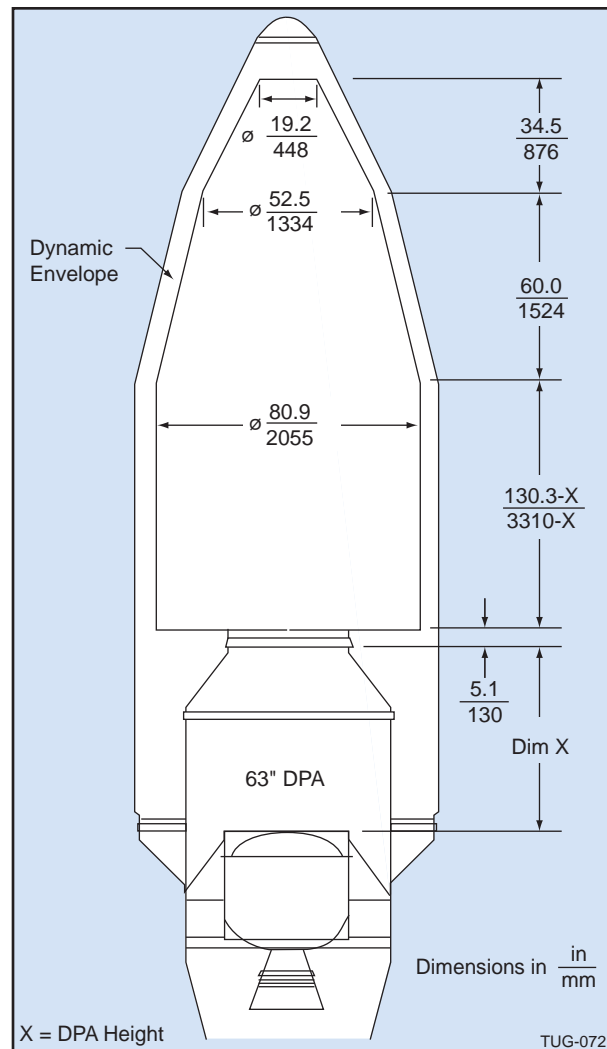


Figure 8-1. 92" Fairing with 63" DPA.

8.1.2 50" DPA

Figure 8-2 depicts the secondary payload configuration utilizing the qualified, flight-proven 50" DPA. The secondary payload is housed within the DPA structure and can be deployed out of this structure following primary payload and DPA forward cone separation. The advantage of this configuration is that the primary payload is completely isolated from the effects of the secondary payload. The 50" DPA is designed to fit within either the 63" or 92" fairings. The DPA is a cylindrical graphite composite shell structure which carries the load of the primary payload. The load path is carried through two mirrored conical-cylindrical sections, and the forward attachment flange of the payload adapter. The height of the DPA

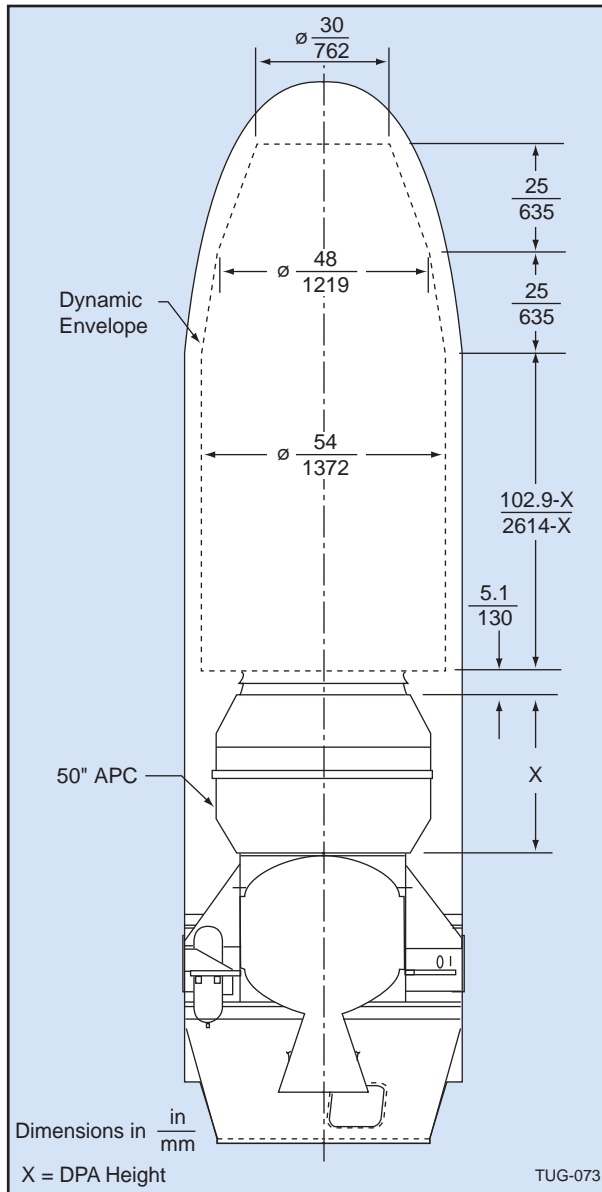


Figure 8-2. 63" Fairing with DPA.

can be adjusted between 30" and 72" to tailor the height of the secondary payload volume as long as the envelope and environmental requirements for the primary payload are not violated. The envelope available for the secondary payload depends upon the primary payload characteristics and the separation dynamics of the secondary payload.

8.2 Payload Fairing Options

Customers can select from a number of services to customize Taurus' payload fairings to meet the

requirements of a particular mission. These services are detailed in the subsequent paragraphs.

8.2.1 Cylinder Doors in Standard Locations

Orbital can provide an additional access door of standard size, 30.5 cm x 30.5 cm (12" x 12") for the 63" fairing and 45.7 cm x 61.0 cm (18" x 24") for the 92" fairing, provided the additional door resides within the allowable door envelope defined in either Figure 5-5 or Figure 5-6, respectively. Orbital will verify, through analysis, the structural integrity of the fairing with the additional door in the desired location. Provided this analysis shows the additional door is feasible, Orbital will then manufacture the additional door and the modified fairing for the mission. This analysis will then be validated in the acceptance test of the flight fairing structure.

8.2.2 Doors in Non-Standard Locations

Orbital can provide an additional access door of standard size, 30.5 cm x 30.5 cm (12" x 12") located in the ogive of the 63" fairing or 45.7 cm x 61.0 cm (18" x 24") located in the biconic section of the 92" fairing. Orbital will verify, through analysis, the structural integrity of the fairing with the additional door in the desired location. Provided this analysis shows the additional door is feasible, Orbital will then manufacture the additional door and the modified fairing for the mission. This analysis will then be validated in the acceptance test of the flight fairing structure.

8.3 Optional Mechanical Interfaces

Orbital offers alternate mechanical interfaces as optional services. These systems are discussed in the following paragraphs along with an optional surface treatment for thermal control purposes.

8.3.1 High Capacity Payload Separation System

Orbital can provide a high capacity payload separation system with a 38.81 inch (986 mm) diameter payload bolted interface. This system provides a significantly higher payload capability at the cost of a somewhat lower tip-off performance and a higher interface shock environment. The separa-

tion system is manufactured for Orbital by Saab Ericsson Space of Sweden. Saab has extensive experience supplying separation systems for a wide range of launch vehicles and payloads. The high capacity Taurus 38" system is based on a separation system with considerable flight heritage.

The separation system is a marmon clamp band design that employs two aluminum interface rings that are clamped by dual, semi-circular stainless steel clamp bands with aluminum clamp shoes. Each of the two retention bolts is severed by a redundantly initiated bolt cutter. Upon band release, the movement and parking of each band is controlled by a set of four extraction spring assemblies and two band catchers that are designed to prevent recontact with the upper ring. Separation velocity is provided by up to eight matched spring actuators that impart up to 27.7 ft-lb (37.6 Joules) of energy. The electrical interface across the separation plane is identical to that of Taurus' standard separation system. The structural capacity of the separation system is detailed in Figure 8-3.

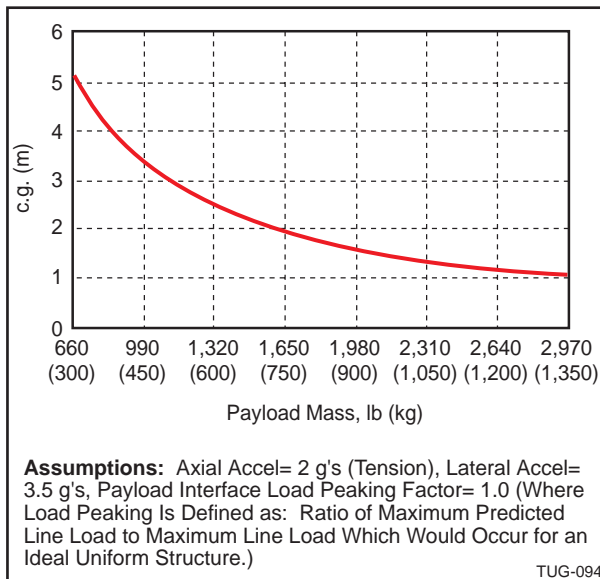


Figure 8-3. High Capacity Payload Separation System Structural Capability.

8.3.2 Non-Separating Payload Interface

Orbital can provide a non-separating payload interface as an optional service. The non-separating interface is a 38.81" diameter bolt circle with 60, equally spaced, 0.257" diameter holes. In this

optional service, the Customer will supply any required separation connectors/harnessing. This harnessing must interface with a connector plate located on the payload support structure.

8.3.3 Separation System Thermal Treatment

As an optional service, the forward ring of the payload separation system can be coated with surface treatments for on-orbit thermal control purposes.

8.4 Payload Isolation System

Orbital offers a flight-proven payload isolation system to facilitate reductions in payload transient and low frequency loads as a non-standard service. This mechanical isolation system has demonstrated the capability to significantly alleviate the dynamic loads induced by the resonant burn and motor ignition environments. The isolation system can provide relief to both the overall payload center of gravity loads and component or subsystem responses.

Figure 8-4 defines the maximum predicted payload interface sine vibration levels for payloads that employ the isolation system.

The payload isolation system consists of a ring of 60 metallic flexures that are installed in place of the bolts normally used at the payload/launch vehicle interface. The entire system is specifically designed to attenuate critical payload responses at frequencies identified through Coupled Loads Analysis. Load reductions of 50% or more are common; however, the actual extent of improvement is dependent on payload/launch vehicle coupled dynamics.

Additional considerations with use of this non-standard service include a reduction in payload/fairing clearance, a small forward offset of the payload (e.g., 25 mm (1.0")), and a reduction in performance associated with the additional mass [typically 9 to 18 kg (20 to 40 lb) per set] of the system. All components comprising the flight isolation system are 100% tested to the maximum predicted static and dynamic load, and thermal environments.

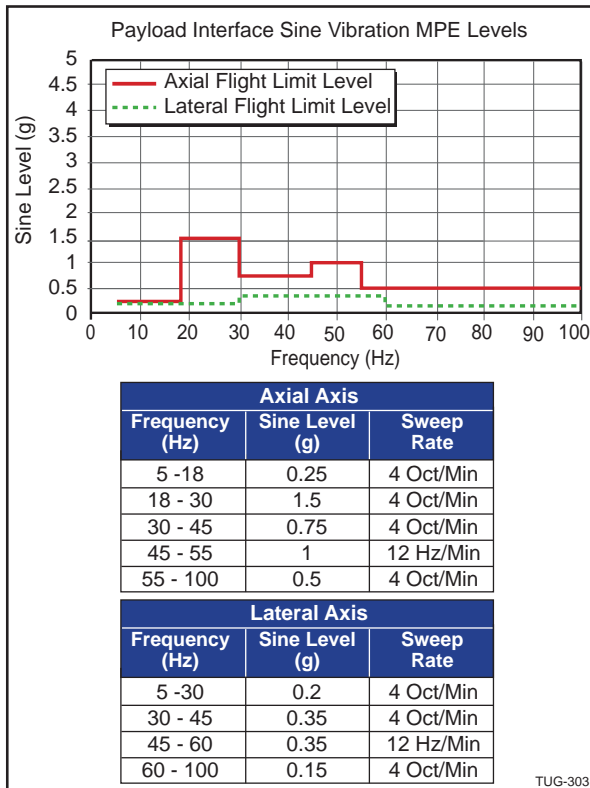


Figure 8-4. Maximum Isolated Sine Vibration Levels.

8.5 High Energy Performance Capability

As a non-standard service, Orbital offers an upper stage motor which is compatible with the standard service four stage Taurus configurations that employ the 63" fairing with either the standard or XL motor configuration (Taurus 2113 and Taurus 3113). Although the upper stage may also be compatible with 92" fairing configured vehicles, assessment of these configurations would have to be made on a mission specific basis.

This service employs a spinning STAR 37FM motor that is mounted to the top of the payload adapter cone via a composite Stage 3/4 interstage and high capacity Saab separation system, as shown in Figure 8-5. This configuration provides substantially improved payload to orbit performance, particularly when used in conjunction with the XL motors and the 63" fairing (Taurus 3113 configuration).

8.5.1 System Description

Under this non-standard service, Orbital provides the STAR 37FM motor and the additional S3/4 in-

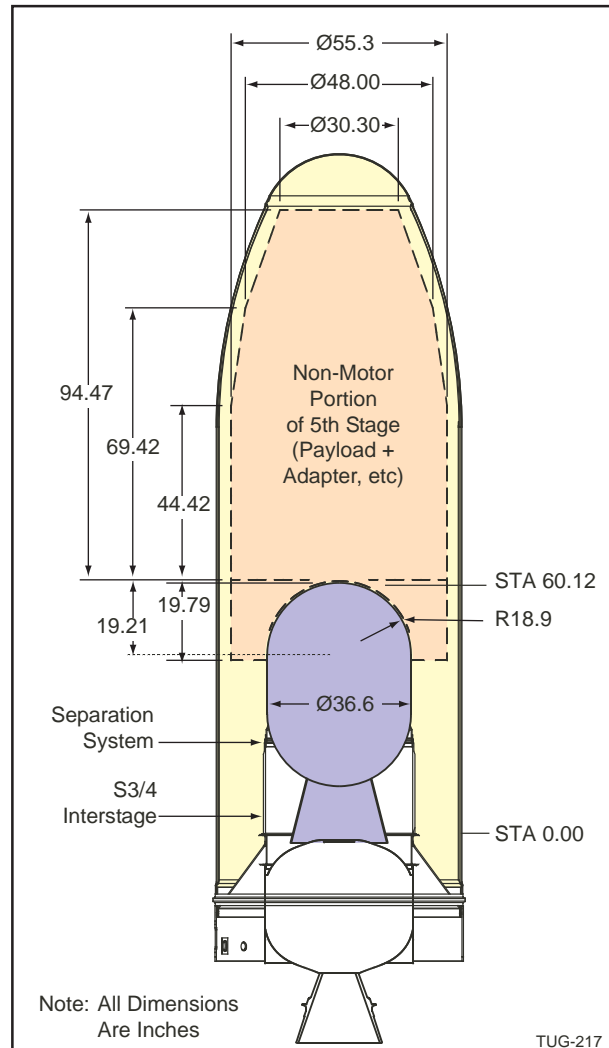


Figure 8-5. Dynamic Envelope for 5th Stage of a Taurus Model 3113.

terstage. The standard Saab separation system is replaced with a high capacity system positioned between the interstage and the STAR 37FM motor. Orbital will provide spin-up using the capabilities of the existing Reaction Control System (RCS) and separate the STAR 37FM from the launch vehicle after Stage 3 burnout. Orbital will provide a separation indication at the STAR 37FM/Stage 3 separation plane. The payload is responsible for STAR 37FM motor ignition, and if required, payload/STAR 37FM nutation control, and de-spin. The payload is also responsible for any additional separation system required to separate the payload from the STAR 37FM motor. This arrangement allows the payload to maximize payload-to-orbit performance by leveraging existing bus

infrastructure to execute the ignition, de-spin and separation functions.

As part of this service, Orbital will re-configure the Flight Termination System (FTS) to move Stage 2 command destruct capabilities to the Stage 3 assembly. STAR 37FM destruct capability will be provided up to the point of STAR 37FM separation. This non-standard service does not include any provisions for command destruct after STAR 37FM separation.

8.5.2 Performance

High energy performance for the Taurus 3113 configuration launched from CCAFS is provided in tabular form in Figure 8-6 and graphically in Figure 8-7. Performance to highly elliptical low earth orbits is provided in tabular form in Figure 8-8.

C3 (km ² s ⁻²)	5th Stage Non-Motor Mass (kg)	C3 (km ² s ⁻²)	5th Stage Non-Motor Mass (kg)
-10	533.0	16	301.4
-5	476.2	18	288.7
-2.6	451.7	20	276.4
-2	445.8	22	264.7
-1	436.0	24	253.2
0	426.4	26	242.4
1	417.1	28	232.1
2	408.4	30	222.0
4	391.1	35	198.6
6	374.3	40	177.2
8	358.3	45	158.2
10	343.4	50	140.6
12	329.1	60	109.9
14	315.0		

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Figure 8-6. Taurus 3113 High Energy Performance (28.5° Inclination, CCAFS Launch).

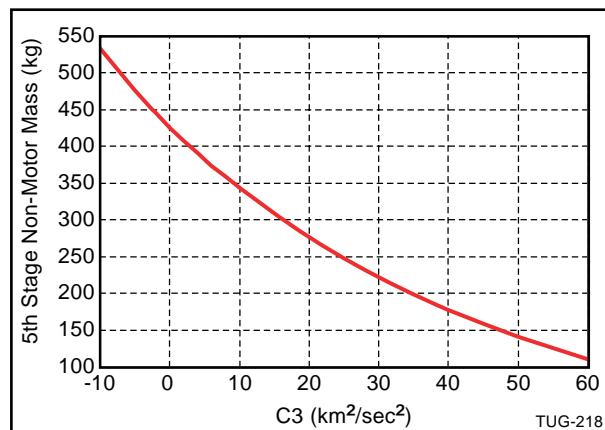


Figure 8-7. Taurus 3113 High Energy Performance (28.5° Inclination, CCAFS Launch).

Apogee (km)	5th Stage Non-Motor Mass (kg)	Remarks
5000	1199.6	
10,000	937.9	
15,000	804.9	
20,000	726.8	
25,000	674.3	
30,000	637.1	
35,788	605.6	Mass values for apogees between 35,000 and 60,000 km are provided for trending purposes only. Trajectories to apogees in this range can-not be flown due to Stage 3 impact on Africa.
40,000	587.7	
50,000	556.6	
60,000	535.1	
70,000	519.5	Mass values for apogees above 60,000 km are provided for trending purposes only. Stage 3 is ballistic with impact in the Indian Ocean and powered over-flight of Africa. As such, these trajectories cannot be guaranteed, i.e., might not meet Range Safety requirements.
80,000	507.5	
90,000	498.1	
100,000	490.5	

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Figure 8-8. Taurus 3113 High Elliptical Performance (185 km Perigee, 28.5°, CCAFS Launch).

STAR 37FM separation attitude accuracy and rates as well as orbital insertion accuracy are highly dependent on final stage mass (including payload) and apogee. As such, these will be evaluated on a mission specific basis as part of each mission analysis. Orbital will assess spin dynamics through STAR 37 FM separation from the launch vehicle as well as tip-off dispersions associated with the separation event. Assessment of post-separation spin dynamics is the responsibility of the Customer. Payload spin balance testing may be required to ensure that desired separation conditions are achieved. Payload spin balance testing, if required, is not included as part of this service.

8.5.3 Mechanical Interface

The available fairing volume is defined in Figure 8-5 for vehicle configurations employing the 63" fairing (Taurus 2113 and 3113). The mechanical interface to the payload will consist of an integrally machined, forward facing flange located on the cylindrical section of the STAR 37FM motor. The flange will have a circular bolt pattern 37.46 inches in diameter and will consist of 24, equally spaced 0.27 inch diameter holes. Figure 8-9 defines the allowable payload center of gravity as a function of mass.

8.5.4 Electrical Interface

The electrical harness interface is the same as that defined for the standard service except that the

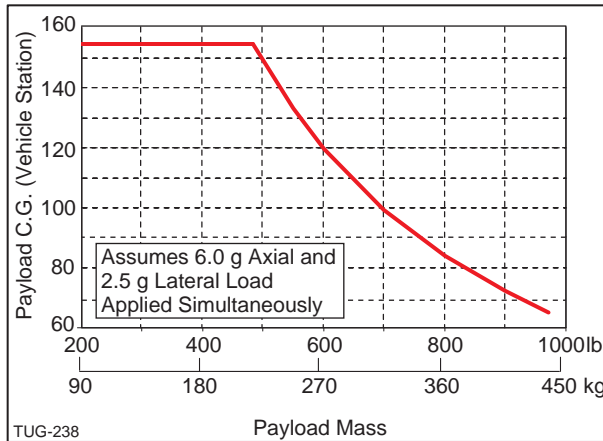


Figure 8-9. Payload Axial C.G. Location as of Function of Mass.

separation plane is defined as the S3/4 separation plane rather than the upper stage-to-payload separation plane. The payload is responsible for the harness from the S3/4 separation plane forward. Orbital will provide the forward halves of the separation connectors as in the standard service.

8.5.5 Payload Environments

The payload dynamic environments are enveloped by those defined for the standard service with the exception of random vibration, which will be defined as part of this service. Payload static axial acceleration as a function of mass is defined in Figure 8-10. The lower bound on acceleration is determined by lower stage burn-out accelerations, which are insensitive to payload mass. Thermal environments are the same as

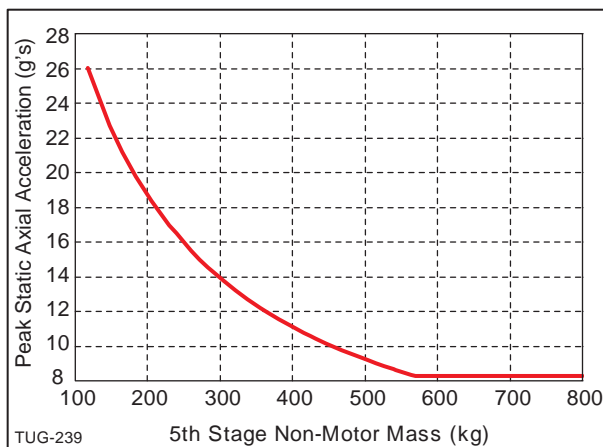


Figure 8-10. Burn-Out Acceleration for STAR-37FM as a Taurus 5th Stage.

those defined for the standard service except for upper stage motor surface temperature, which will be defined as part of this service.

8.6 Alternate Integration and Launch Sites

Orbital's Taurus launch vehicle is designed to be highly mobile and readily deployed from an austere site with minimal services required from the host range. The primary requirement is a 40' x 40' concrete pad capable of supporting the weight of the Taurus vehicle. The Orbital launch support equipment is transportable and, for the most part, satisfies the needs traditionally supplied by fixed launch site facilities. In our work with various Customers, we have analyzed and performed site surveys for operating from other ranges. Orbital offers launch services from South VAFB, CCAFS, WFF and Kwajalein as non-standard services.

8.6.1 South Vandenberg Air Force Base

To provide additional payload capacity for some high inclination orbits (typically 60°-90° inclinations), Orbital offers a SVAFB launch site as an alternative launch location. Orbital has conducted preliminary evaluations on SVAFB sites that can accommodate Taurus including California Spaceport and SLC-5. Therefore, if a South Base launch is required, Orbital will make contingencies to provide a launch site that is similar to our existing facility on NVAFB. The normal Taurus integration process will apply with the only differences being the hardware will be transported to our new launch site on South VAFB instead of our standard site on North Base, 576E.

8.6.2 Cape Canaveral Air Force Station

Taurus integration operations at the Eastern Range mirror those conducted at the Western Range. The obvious difference is that payload processing as well as the final vehicle integration and launch occurs at CCAFS.

For an Eastern Range launch, Orbital integrates the Taurus stages at VAFB. Once the vehicle has completed stage integration and preliminary systems testing, the Taurus stages are delivered to the launch site at CCAFS and the Taurus payload cone and fairing are delivered to the PPF.

Like Astrotech at VAFB, Orbital will provide a PPF for commercial Taurus Customers. The PPF will provide the same basic support and services required to integrate, test and encapsulate the payload.

For CCAFS launches, Orbital will use the commercial Launch Complex 46 (LC-46), developed by the Spaceport Florida Authority in conjunction with launch industry partners (including Orbital). LC-46, shown in Figure 8-11 and Figure 8-12, is a proven commercial launch facility capable of supporting a variety of launch vehicles. Following integration at VAFB, Taurus hardware will be shipped to CCAFS via rail and truck. Once at LC-46, Orbital will perform standard launch site integration procedures to verify the hardware was not damaged during transport, mate the encapsulated cargo element with the Taurus vehicle, conduct the integrated systems tests, and perform the final erection and close-out of the vehicle.



Figure 8-11. LC-46 Launch Complex.

8.6.3 Wallops Flight Facility

Wallops Flight Facility (WFF) offers ground-based launch vehicles the capability to obtain middle inclinations orbits, typically between 40 and 60 degrees.

Spaceport Virginia has a flat pad capability similar to what Taurus currently uses at VAFB Site 576E. Additionally, the Spaceport has acquired the facilities associated with the pad such as an access gantry that can be used for Taurus launches. Primary integration of the Taurus vehicle will be conducted at Orbital's VAFB integration facilities.

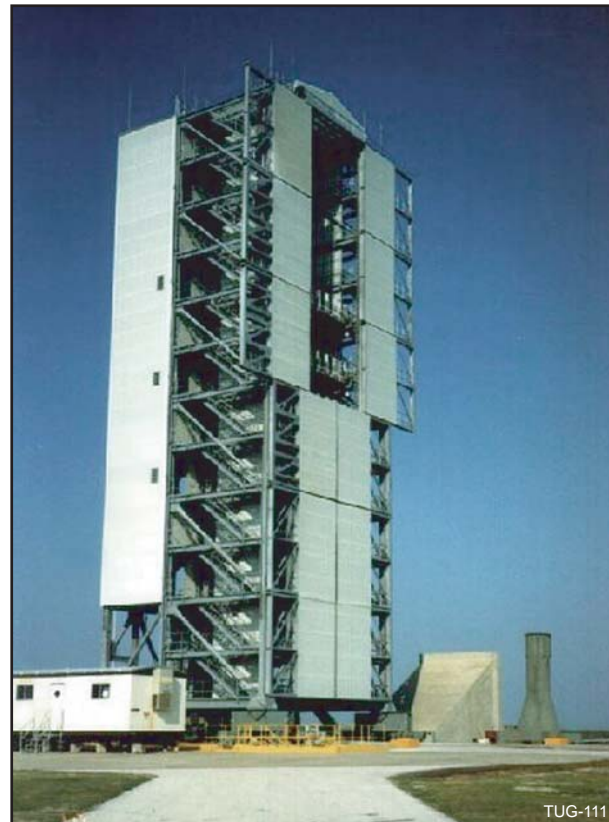


Figure 8-12. LC-46 Tower.

Following this integration the vehicle, EGSE, and MGSE would be shipped to WFF.

Once at WFF, the vehicle will be inspected and tested to the procedures currently used at VAFB. Payload encapsulation can occur at any facility compatible with Orbital's Taurus fairing encapsulation process and associated GSE. Launch site integration will be conducted with the same procedures that are currently part of Taurus integration and that have been approved by range safety.

8.6.4 Reagan Test Site – Kwajalein, Marshall Islands

For payloads requiring a low inclination launch capability, Orbital offers launch services from the Reagan Test Site (RTS) on the Kwajalein Atoll. Similar to operations for other alternate launch sites, Taurus would be initially integrated and tested at VAFB. Following successful testing, the launch vehicle flight hardware and ground support equipment would be transported via ship and aircraft to RTS where final integration, systems

testing, payload mating, stacking and closeout of the vehicle would take place. Once all hardware is at the launch site, Taurus vehicle assembly and testing will be performed similar to the existing processes at VAFB.

A launch from RTS will be an austere launch campaign similar to early Taurus missions. Specific facilities for a Taurus launch from RTS do not currently exist and must be constructed. Fortunately, Taurus was designed for mobility and for launching from austere sites and requires only a minimum of facilities for performing the launch operations.

As part of this non-standard service, Orbital will perform the following activities:

- Construct a suitable pad, augment existing infrastructure as required for a Taurus launch, and execute the Environmental Assessment process;
- Transport launch vehicle hardware and support equipment to RTS;
- Update integration procedures affected by the change in launch site;
- Complete the flight and ground safety review and approval process;
- Coordinate the RTS Range services; and
- Provide standard RTS support equipment, including aerial manlifts (150 ft), a 150 ton crane, forklifts and truck support, and other more typical Range support services.

This non-standard service does not include a payload processing facility (typical payload processing facilities do not exist at Kwajalein) or shipment of the payload to Kwajalein. Orbital is willing to assist the Customer in determining what payload processing and shipping options are best suited to a particular payload's needs.

8.7 Contamination Control Options

Understanding that payloads have varying requirements for cleanliness, Orbital offers a number of contamination control options. Taurus Customers can select any combination of these

options to meet the unique needs of their payloads.

8.7.1 Fairing Environment

As a non-standard service, Orbital can purge the fairing environment, from payload encapsulation through launch, with either FED-STD-209 level M5.5 (Class 10,000) or level M4.5 (Class 1,000) filtered air. Orbital will accomplish continuous particulate monitoring and verification of the supply air via probes installed into the fairing inlet duct.

8.7.2 Fairing Internal Surface Cleaning

Orbital can provide enhanced fairing internal surface cleaning using MIL-STD-1246C as a guideline toward achieving Level 500A cleanliness. Specifically, Orbital can perform the following activities.

1. Clean the fairing inner walls to Visibly Clean-Highly Sensitive (VC-HS) level per Contamination Control Requirements, JSC-SN-C-0005;
2. Clean and verify the fairing acoustic blankets to MIL-STD-1246C Level 500A; and
3. Line the payload cone assembly with aluminum foil, cleaned and verified to MIL-STD-1246C Level 500A.

8.7.3 Payload/Vehicle Integration Environment

As a non-standard service, the payload processing area can be maintained in a FED-STD-209 Class M5.5 (10,000) or Class M4.5 (1,000) clean room environment, as required by the payload.

8.7.4 Instrument Purge System

As a non-standard service, Orbital can provide an instrument purge system capable of delivering MIL-P-27401 Grade B gaseous nitrogen to a quick-disconnect fitting on the payload from payload encapsulation to liftoff. The nitrogen supply system is equipped with a flow rate metering panel that can be configured to meet spacecraft requirements for flow rate and particulate filtering. The panel features a replaceable metering orifice. Orifices can be selected to provide a flowrate in the range of 0.01 to 25 SCFM. The system also includes a particulate filter and pressure switches

used to continuously monitor system operation. The entire nitrogen system is precision cleaned to MIL-STD-1246C Level 100A. The purity of the nitrogen flowing through the system is certified prior to connecting to the spacecraft. The purge tubing connected to the payload is pulled away during fairing separation. The quick disconnect system exerts less than 50 lbf on the payload fitting.

8.7.5 Spot Cooling with Grade B Nitrogen or Pure Air

Orbital can provide spot cooling of payload components from payload encapsulation to liftoff by locating nozzles within the fairing to direct Grade B gaseous nitrogen at the spacecraft as required. Up to six (6) separate nozzle positions can be specified with a total maximum flow rate of 25 SCFM. The nitrogen cooling system is cleaned to MIL-STD-1246C Level 100A. The purity of the nitrogen flowing through the system is certified prior to use.

If greater cooling is required than possible with directed nitrogen, Orbital can also supply spot payload cooling via directed filtered air. The purge air duct inside the Taurus fairing can be modified to direct a portion of the incoming purge air at a single payload component or area. The flowrate may be up to 25% of the total flowrate provided to the fairing by the Taurus ECS. The cleanliness of the spot cooling air will match that provided to the fairing.

8.7.6 Hydrocarbon Scrubbing and Monitoring

If required, Orbital can perform routine hydrocarbon monitoring and verification of the payload processing facility air supply from payload arrival through payload encapsulation via a probe inserted into the duct downstream of the carbon pre-filters. Carbon pre-filters will be incorporated into the fairing conditioned air supply system from payload encapsulation through vehicle stack.

8.8 Mobile Scaffold Vehicle Access Structure at VAFB

As a non-standard service, Orbital can provide a mobile scaffold structure at Launch Site 576E allowing physical access to all elements of the launch vehicle including the payload fairing. The scaffolding would replace the use of aerial man-lifts for launch vehicle and payload arming activities and could serve as a platform for mission specific payload GSE, if the need exists. The structure will accommodate up to 5,000 lbs of payload equipment, spread equally over a minimum of two platforms. Up to 100 square feet of floor space on the structure will be provided to stage payload equipment.

Upon Western Range and environmental approvals, Launch Site 576E would be modified to incorporate an above ground rail system upon which a scaffolding structure would be erected. The scaffold would be positioned around the launch vehicle during pre-launch activities. Prior to launch the scaffold would be moved to a safe position for the launch event and secured in place.