MDC 00H0043

DELTA IV

Payload Planners Guide
Update — April 2002

DELTA IV
PAYLOAD PLANNERS GUIDE

Update—April 2002

The Delta IV Payload Planners Guide Update—April 2002 has been cleared for public release by the Chief, Air Force Division, Directorate for Freedom of Information and Security Review, Office of the Assistant Secretary of Defense, as stated in letter 02-S-1133 dated April 16, 2002.

THIS DOCUMENT SUPPLEMENTS THE COMMERCIAL DELTA IV PAYLOAD PLANNERS GUIDE, MDC 00H0043, DATED OCTOBER 2000.

The Boeing Company
5301 Bolsa Avenue, Huntington Beach, CA 92647-2099 (714) 896-5195

CHANGE RECORD

Revision Date	Version	Change Description
Update April 2002	October 2000	Section 1—updates include: ■ Revised Figure 1-6 (Section 1.2.5) ■ Supplemental information on dual-manifest capability Section 1.2.6) ■ New Figures 1-9, 1-10, and 1-11 (Section 1.2.6)
		Section 2—updates include: ■ Supplemental information on GTO mission profiles (Section 2.2.1) ■ New Figures 2-39, 2-40, and 2-41 (Section 2.2.1) ■ Supplemental information on direct inject to GEO (new Section 2.2.1.1) ■ New Table 2-4 (Section 2.2.1.1) ■ Supplemental information on Delta IV Heavy dual-manifest GTO missile profile (Section 2.2.4) ■ New Figure 2-4A, revised Figure 2-8 (Section 2.2.4) ■ Supplemental information on C_3 performance (new Section 2.2.6) ■ New Table 2-5 (Section 2.2.6)
		Section 3—updates include: ■ Revised last paragraph (Section 3.2) ■ Revised Figures 3-9 and 3-10 (Section 3.2)
		Section 4—updates include: ■ Supplemental information on low-shock separation system (new Section 4.2.3.5.2) ■ New Figure 4-35 (Section 4.2.3.5.2) ■ Updated Table 4-13 (Section 4.2.5)
		Section 6—updates include: ■ Supplemental information on Astrotech Building 9 dual-manifest payload processing (Section 6.2.1.9) ■ New Figure 6-12A (Section 6.2.1.9) ■ Supplemental information on mobile service tower (Section 6.4.1)
		Section 8—updates include: ■ Revised discussion on payload integration (pages 8-1 through 8-9 and 8-21) ■ Deleted Figure 8-1 (Section 8.1) ■ Revised Figures 8-2 (Section 8.1); Figure 8-4 and Tables 8-1, 8-2, 8-3, and 8-6 (Section 8.2)

PREFACE

This update to the October 2000 edition of the Delta IV Payload Planners Guide (PPG) provides both updated and additional information concerning vehicle performance capabilities, a new dual manifest approach, a new low-shock clampband, and a new baseline 18-month mission integration cycle.

Currently, the next update to the Delta IV PPG is planned for late 2002, after the inaugural Delta IV flight and a full revision is expected in mid-2003. This update maintains the same paragraph numbering system as the October 2000 Delta IV PPG, MDC 00H0043.

In an effort to provide consistent and better service to our customers, Boeing Delta and Sea Launch integrated their commercial sales and marketing organizations. The new organization, Boeing Launch Services (BLS), offers commercial sales and marketing services for both Delta and Sea Launch. Mr. Will Trafton is the president of BLS.

General and mission-specific inquiries regarding launch service availability and pricing, and the technical content of this update or the Delta IV PPG, should be directed to:

Boeing Launch Services
Phone: (714) 896-5195
Fax: (714) 896-1196
Email: launchservices@boeing.com

Mailing address:

Boeing Launch Services
c/o The Boeing Company
5301 Bolsa Avenue
Huntington Beach, CA 92647-2099
Attn: H014-C456

Visit us at our Boeing Launch Services Web site: www.boeing.com/launch

Section 1 Update
LAUNCH VEHICLE DESCRIPTION

1.2.5 Payload Fairings (PLF) (Updated Figure)

The fairings protect the payload once the payload is encapsulated through boost flight. The Delta IV launch system offers PLFs (Figure 1-6) for different launch vehicle configurations.

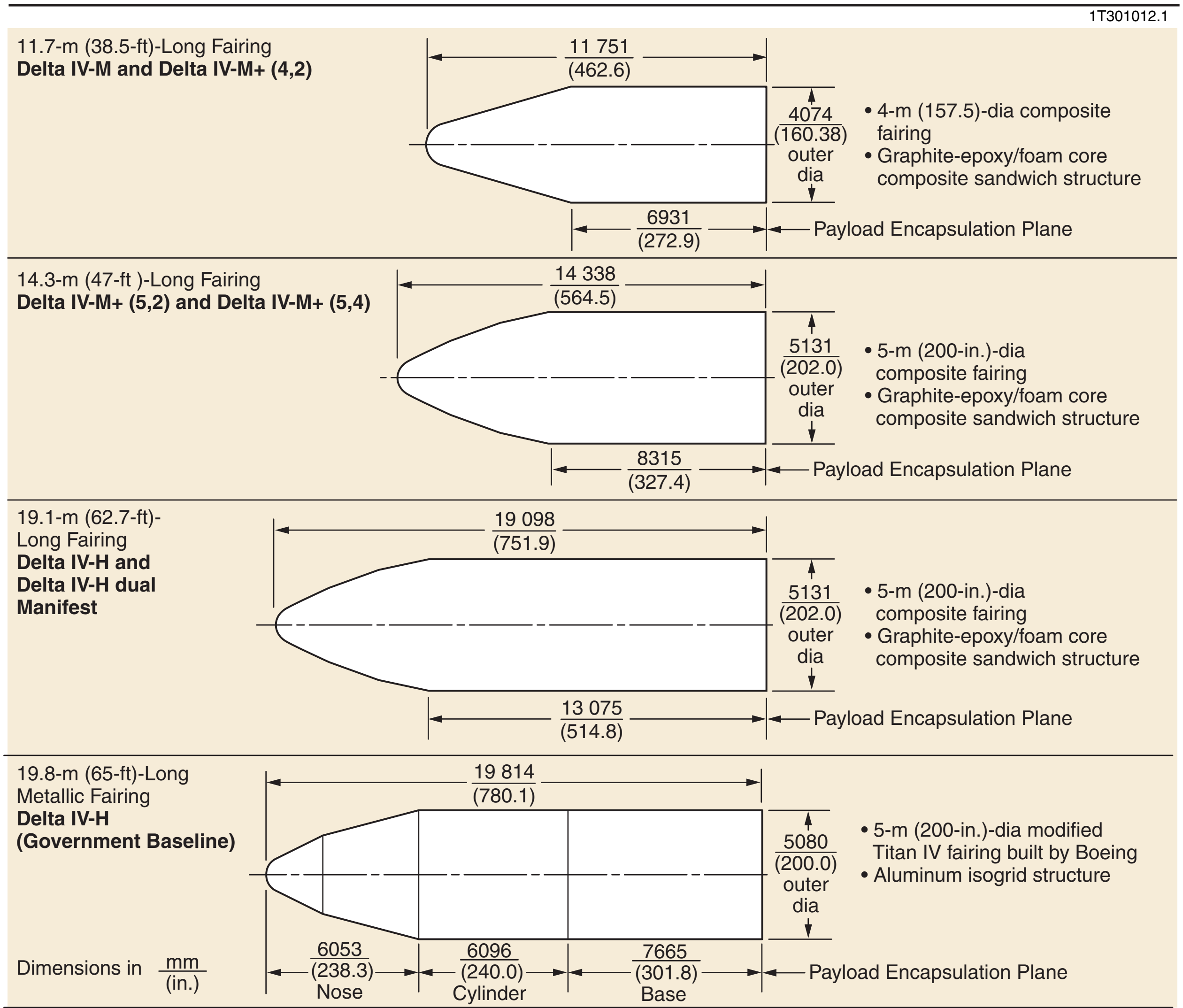

Figure 1-6. Delta IV Fairing Configurations (Same updates apply to Figure 3-1 in the Delta IV PPG.)

1.2.6 Dual-Manifest Capability (Supplemental Information)

The Delta IV launch system offers dual-manifest capability utilizing the Heavy configuration. This dual-manifest system provides payload autonomy similar to a dedicated launch, and the price advantages of a shared launch. The Delta IV dual-manifest launch system currently has the capability of launching two spacecraft totaling up to 9860 kg (21,840 lb) separated mass to a standard delivery orbit of 271-km perigee by 71,572-km apogee at 23.3 deg of inclination geosynchronous transfer orbit using a 5-m composite fairing that is 19.1m (62.7 ft) long.

The Delta IV Heavy dual-manifest system uses the dual-payload attach fitting (DPAF-5) hardware shown in Figure 1-9. This dual-manifest system is evolved from the Astrium-built, flight-proven DPAF system used on Delta II. We are continuing to work on the DPAF-5 design, which will be a slightly modified version of the flight-proven SYLDA-5 dual-manifest system.

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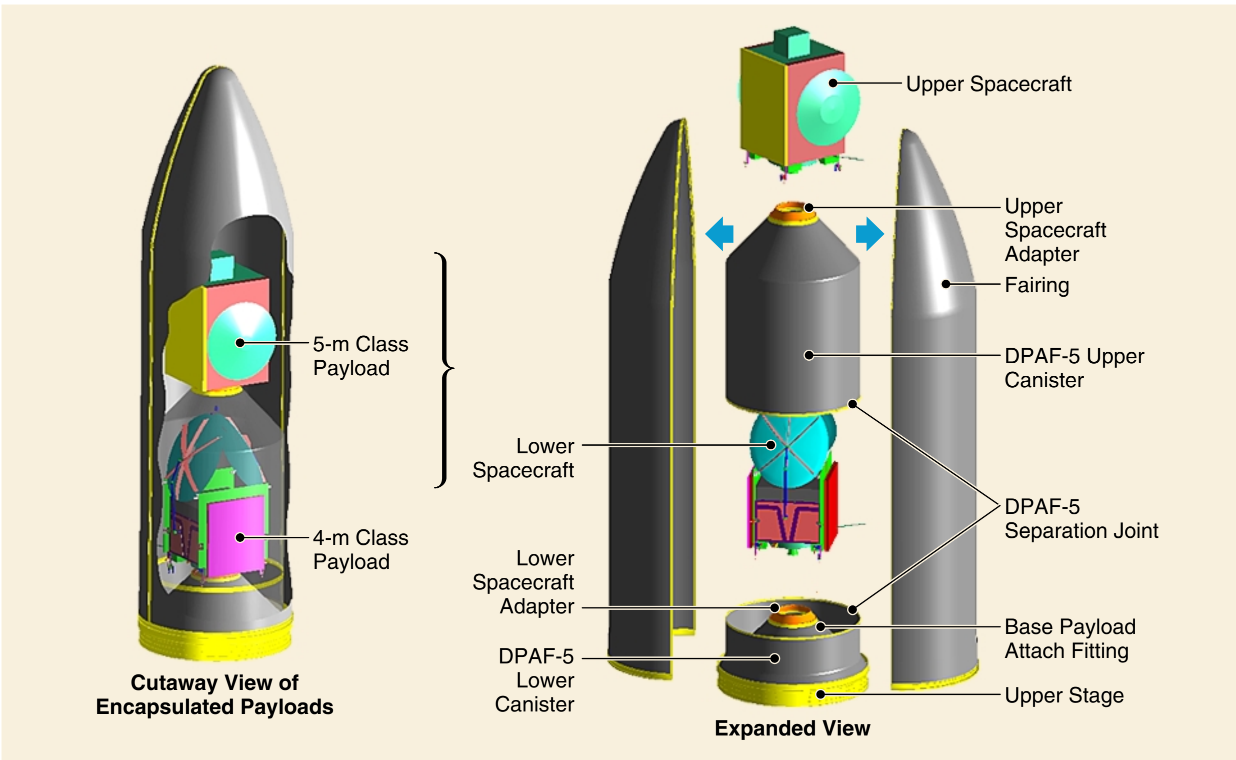

Figure 1-9. Delta IV Heavy Dual-Payload Attach Fitting (DPAF-5)

The Delta IV Heavy will support two standard versions of DPAF-5, which have been designed to meet a broad spectrum of mission requirements. The DPAF-5 Long, which uses the 8-m (26.2-ft)-long DPAF-5, can accommodate medium-class payloads in both the upper and lower bays. The DPAF-5 Short, which uses the 6.8-m (22.3-ft)-long DPAF-5, can accommodate a large-class payload in the upper bay, with a small- to medium-class payload in the lower bay. When matching copassengers, Delta IV Heavy dual-manifest payload classes are defined as follows:

- Small class: less than ~2,500 kg
- Medium class: between ~2,500 kg and ~5,500 kg
- Large class: greater than ~5,500 kg

For operational purposes, the interface between both payloads and the launch vehicle will use an established spacecraft adapter design. The spacecraft adapters will mate to the DPAF-5 structure and extend upward to the required payload interface (i.e., 937-mm clampband, 1194-mm clampband, 1666-mm clampband, or 1664-mm bolted interface). The standard spacecraft adapter interface allows considerable flexibility in accommodating payloads in either the upper or lower payload position and if required, off-loading payloads to dedicated Delta IV launch vehicles (Figure 1-10). A spacecraft adapter is assigned to each specific payload at contract award, and will be used regardless of the final launch system (dedicated or dual manifest) selected to deploy the satellite. The spacecraft adapter approach also provides customers with a single fit-check, independent of the Delta IV launch system, while simplifying shipping logistics (due to the compact shipping size of the spacecraft adapter).

Boeing has developed a comprehensive understanding of payload compatibilities, with copassengers being identified by analyzing various combinations of commercial satellite buses. The baseline copassenger matching process (Figure 1-11) begins with a compatibility analysis to determine possible mass and size combinations of customer payloads. This analysis will consider each payload's launch window, packaging, RF, and performance requirements to assure a compatible pairing. Once an optimal pairing is defined, Boeing will perform further analyses to verify dynamic compatibility of the dual-manifest launch system as well as compatibility of the payload with a dedicated off-load launch service that may be used for launch schedule protection. Boeing will notify the customer of the identity of its copassenger as soon as a compatible payload has been identified and verified.

During the mission integration process, Boeing will analyze requirements for each payload to determine optimum positioning for a dual-manifested launch. The upper and lower payload bays can individually accommodate satellites up to 7,000 kg in mass with a center of gravity of up to 2.0 m above the separation plane. Some of the primary technical requirements that will be evaluated in determining the optimum positioning are payload size and mass, center of gravity, electrical and RF signal requirements/compatibility, etc.

By virtue of the high commonality across the entire Delta IV family of launch services, Boeing has the unique ability to transition from Delta IV Heavy dual-manifested launch services to dedicated launch services on the Delta IV Medium and Medium-Plus vehicles. In the event that a compatible copassenger is not identified, or a copassenger satellite is delayed, Boeing is able to efficiently transition the customer payload to a dedicated Delta IV launch service (Figure 1-10), thus providing schedule assurance. The process of off-loading payloads to a dedicated launch service is facilitated by the assignment of a specific spacecraft adapter interface for each individual payload. This spacecraft adapter can be flown in either position on the dual-manifested vehicle or on any Delta IV dedicated launch systems.

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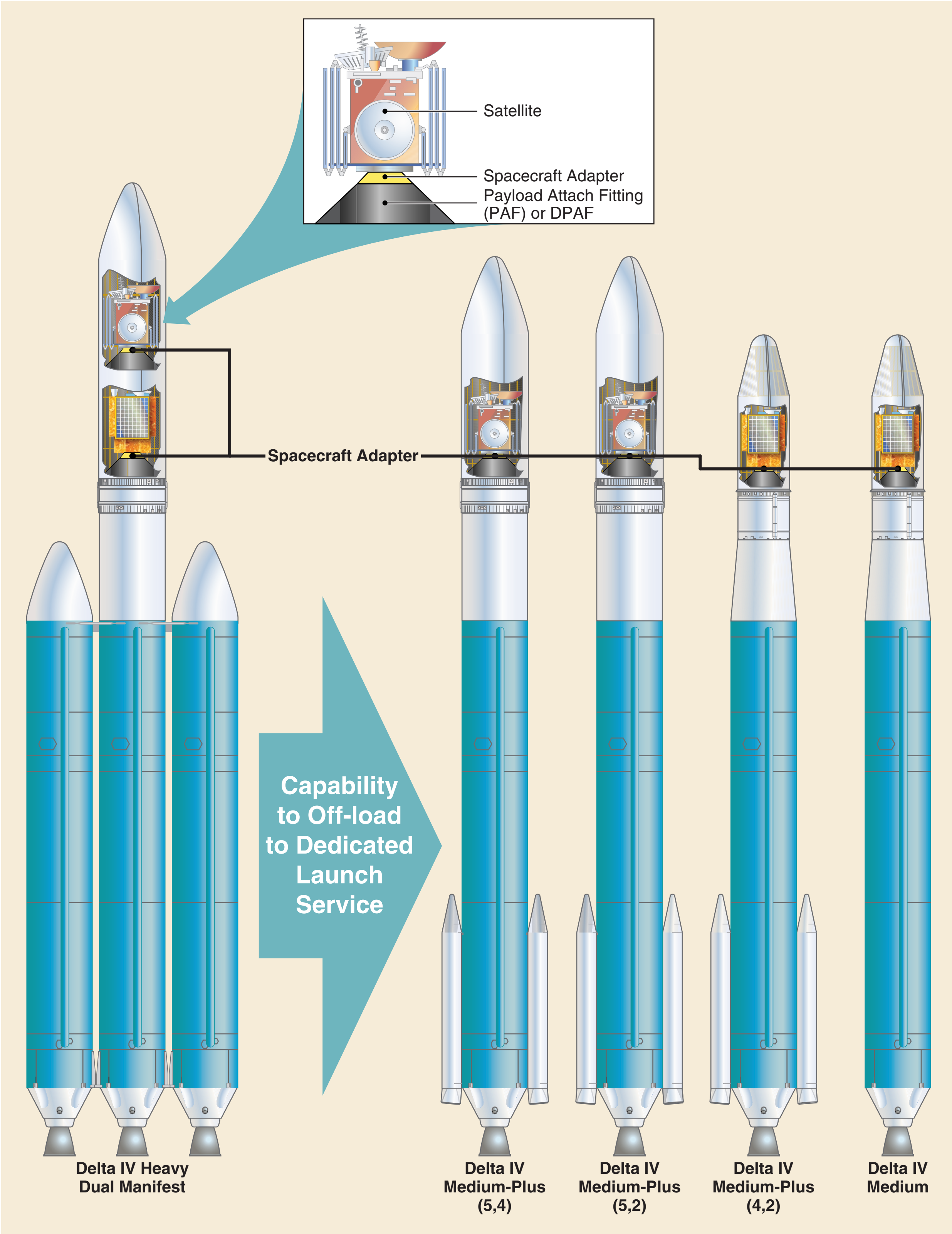

Figure 1-10. A dedicated spacecraft adapter provides launch service flexibility to assure launch schedule.

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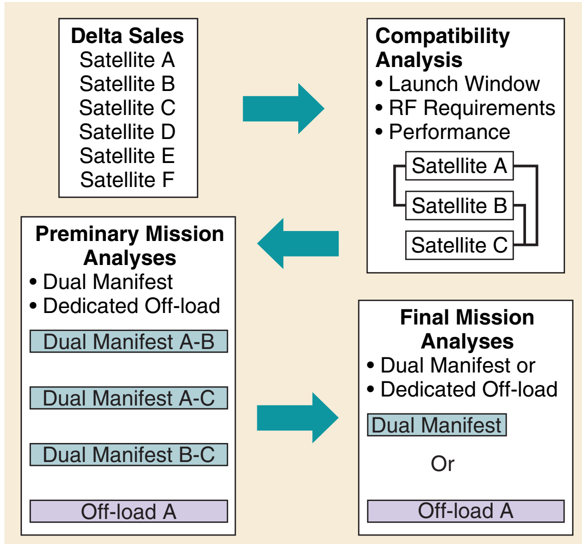

Figure 1-11. Customer launch schedule protected through parallel mission analyses and dedicated off-load.

Section 2 Update
GENERAL PERFORMANCE CAPABILITY

2.2.1 GTO Mission Profile (Supplemental Information)

The standard Delta IV GTO mission profile uses two burns of the second stage. The Delta IV family of launch vehicles is capable of an apogee burn or third burn of the second stage to enhance performance for certain payload mass ranges to GTO. Through the addition of a long-duration mission kit to accommodate mission durations of up to 6.5 hours, Delta IV can perform three burns to raise perigee and/or lower inclination, which will be performed at an apogee altitude of 35,786 km (19,323 nmi). For some spacecraft mass ranges, this provides the benefit of a lower spacecraft ΔV to GEO than the standard two-burn mission profile. Figures 2-39, 2-40, and 2-41 provide spacecraft ΔV-to-GEO curves for two-burn and three-burn cases for the Delta IV-M+ (4,2), (5,4), and Heavy. The Delta IV Medium currently is being evaluated for three-burn missions; information will be available in the next PPG update. For specific mission analyses or questions about these new curves, please contact Boeing Launch Services.

2.2.1.1 Direct Inject Into GEO. Table 2-4 shows direct-inject-to-GEO performance numbers for Delta IV-M+ (4,2), Delta IV-M+ (5,4), and Delta IV Heavy.

Table 2-4. Direct Inject to GEO

Orbit = 35,786 x 35,786 km at 0 deg	
Vehicle	**Separated spacecraft mass**
Delta IV-M+ (4,2)[(a)]	1,611 kg
Delta IV-M+ (5,4)[(b)]	2,412 kg
Delta IV Heavy[(b)]	6,275 kg

[(a)]1194-4 PAF (240 kg)
[(b)]1194-5 PAF (386 kg)
Note: 99.865% PCS

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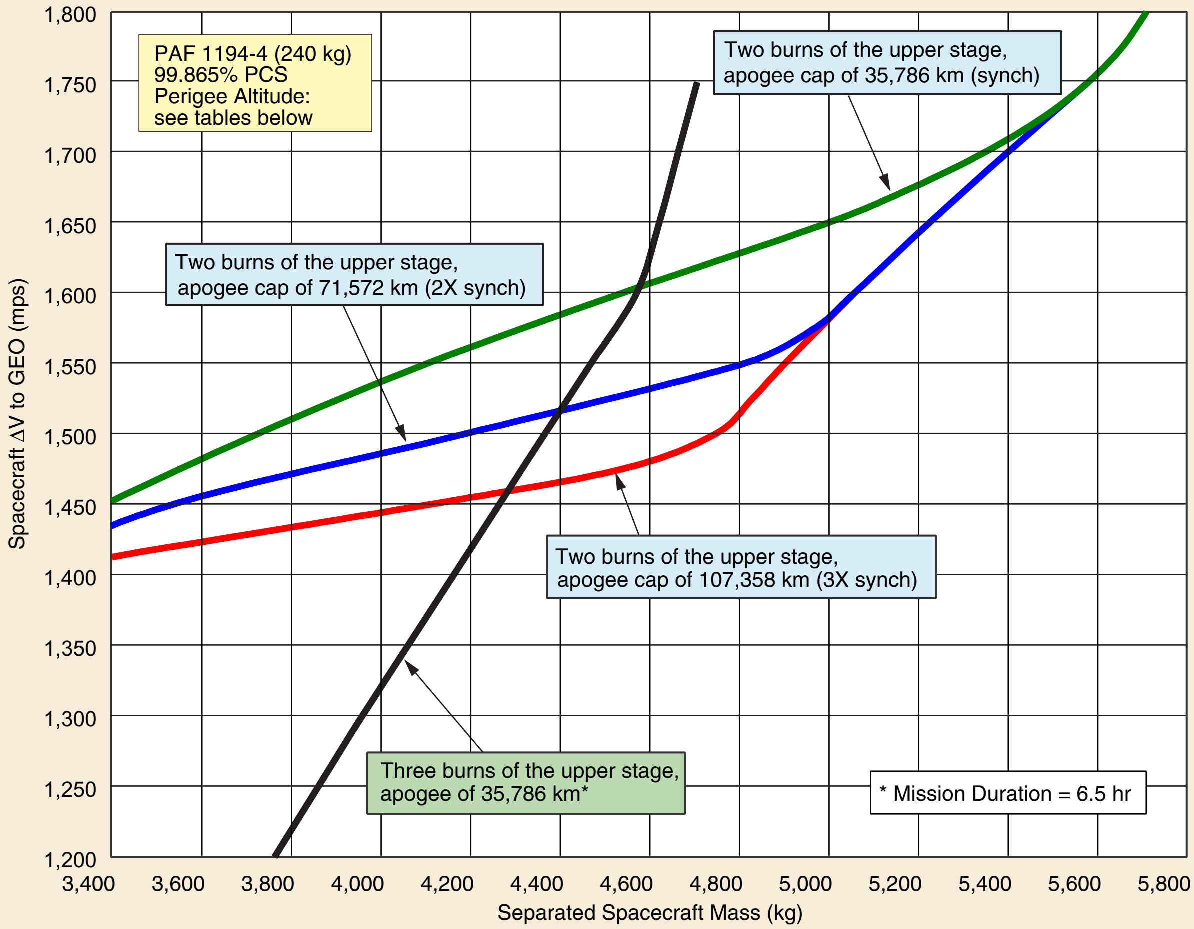

Two-Burn Apogee Cap = 35,786 km (Synch)	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,800 m/sec	213 x 35,786 km at 26.9 deg
1,750 m/sec	219 x 35,786 km at 24.5 deg
1,700 m/sec	223 x 35,786 km at 22.0 deg
1,650 m/sec	235 x 35,786 km at 19.3 deg
1,600 m/sec	472 x 35,786 km at 17.5 deg
1,550 m/sec	1,050 x 35,786 km at 17.2 deg
1,500 m/sec	1,869 x 35,786 km at 17.8 deg
1,450 m/sec	3,179 x 35,786 km at 19.4 deg

Two-Burn Apogee Cap = 71,572 km (2X Synch)	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,750 m/sec	218 x 35,796 km at 24.5 deg
1,700 m/sec	217 x 43,437 km at 25.1 deg
1,650 m/sec	213 x 53,691 km at 25.8 deg
1,600 m/sec	211 x 67,577 km at 26.5 deg
1,550 m/sec	220 x 71,572 km at 23.1 deg
1,500 m/sec	429 x 71,572 km at 18.8 deg
1,450 m/sec	1,547 x 71,572 km at 19.2 deg
1,400 m/sec	4,866 x 36,792 km at 20.9 deg

Two-Burn Apogee Cap = 107,358 km (3X Synch)	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,600 m/sec	211 x 67,570 km at 26.5 deg
1,550 m/sec	209 x 86,575 km at 27.2 deg
1,500 m/sec	211 x 107,356 km at 26.3 deg
1,450 m/sec	291 x 107,358 km at 19.1 deg
1,400 m/sec	4,866 x 36,792 km at 20.9 deg

Three-Burn Apogee = 35,786 km	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,750 m/sec	391 x 33,106 km at 22.9 deg
1,700 m/sec	1,432 x 34,127 km at 22.7 deg
1,650 m/sec	1,452 x 35,182 km at 22.5 deg
1,600 m/sec	1,523 x 35,786 km at 21.6 deg
1,550 m/sec	1,875 x 35,786 km at 20.3 deg
1,500 m/sec	2,284 x 35,786 km at 19.2 deg
1,450 m/sec	2,714 x 35,786 km at 18.1 deg
1,400 m/sec	3,167 x 35,786 km at 17.0 deg
1,350 m/sec	3,663 x 35,786 km at 16.1 deg
1,300 m/sec	4,209 x 35,786 km at 15.2 deg
1,250 m/sec	4,733 x 35,786 km at 14.3 deg
1,200 m/sec	5,297 x 35,786 km at 13.4 deg

Figure 2-39. Delta IV-M+ (4,2) GTO Performance Capability

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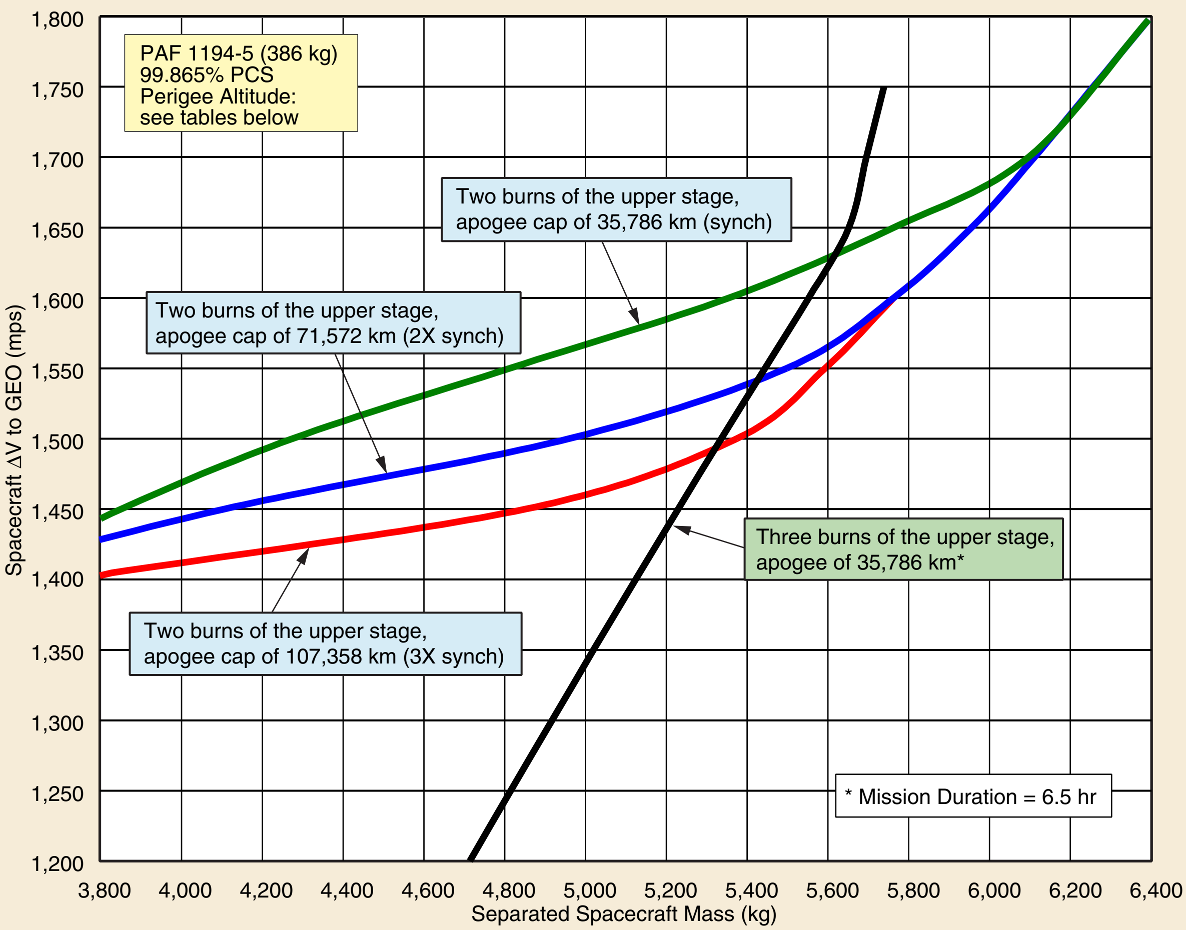

Two-Burn Apogee Cap = 35,786 km (Synch)	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,800 m/sec	322 x 35,786 km at 27.2 deg
1,700 m/sec	354 x 35,786 km at 22.5 deg
1,650 m/sec	375 x 35,786 km at 19.9 deg
1,600 m/sec	429 x 35,786 km at 17.2 deg
1,550 m/sec	574 x 35,786 km at 14.8 deg
1,500 m/sec	1,425 x 35,786 km at 16.0 deg
1,450 m/sec	2,238 x 35,786 km at 16.5 deg
1,400 m/sec	3,329 x 35,786 km at 17.5 deg

Two-Burn Apogee Cap = 71,572 km (2X Synch)	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,800 m/sec	322 x 35,786 km at 27.2 deg
1,700 m/sec	338 x 39,795 km at 24.1 deg
1,650 m/sec	338 x 49,371 km at 24.8 deg
1,600 m/sec	335 x 62,380 km at 25.4 deg
1,550 m/sec	350 x 71,569 km at 23.7 deg
1,500 m/sec	431 x 71,570 km at 18.8 deg
1,450 m/sec	987 x 71,572 km at 16.2 deg
1,400 m/sec	2,479 x 71,572 km at 18.3 deg

Two-Burn Apogee Cap = 107,358 km (3X Synch)	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,575 m/sec	332 x 71,199 km at 25.9 deg
1,550 m/sec	332 x 80,995 km at 26.2 deg
1,500 m/sec	327 x 107,069 km at 26.7 deg
1,450 m/sec	413 x 107,358 km at 19.8 deg
1,400 m/sec	1,297 x 107,358 km at 16.7 deg

Three-Burn Apogee = 35,786 km	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,750 m/sec	1,123 x 35,786 km at 27.1 deg
1,700 m/sec	1,140 x 35,786 km at 25.0 deg
1,650 m/sec	1,312 x 35,786 km at 23.3 deg
1,600 m/sec	1,529 x 35,786 km at 21.6 deg
1,550 m/sec	1,927 x 35,786 km at 20.5 deg
1,500 m/sec	2,350 x 35,786 km at 19.4 deg
1,450 m/sec	2,794 x 35,786 km at 18.3 deg
1,400 m/sec	3,260 x 35,786 km at 17.3 deg
1,350 m/sec	3,743 x 35,786 km at 16.3 deg
1,300 m/sec	4,265 x 35,786 km at 15.4 deg
1,250 m/sec	4,816 x 35,786 km at 14.5 deg
1,200 m/sec	5,379 x 35,786 km at 13.6 deg

Figure 2-40. Delta IV-M+ (5,4) GTO Performance Capability

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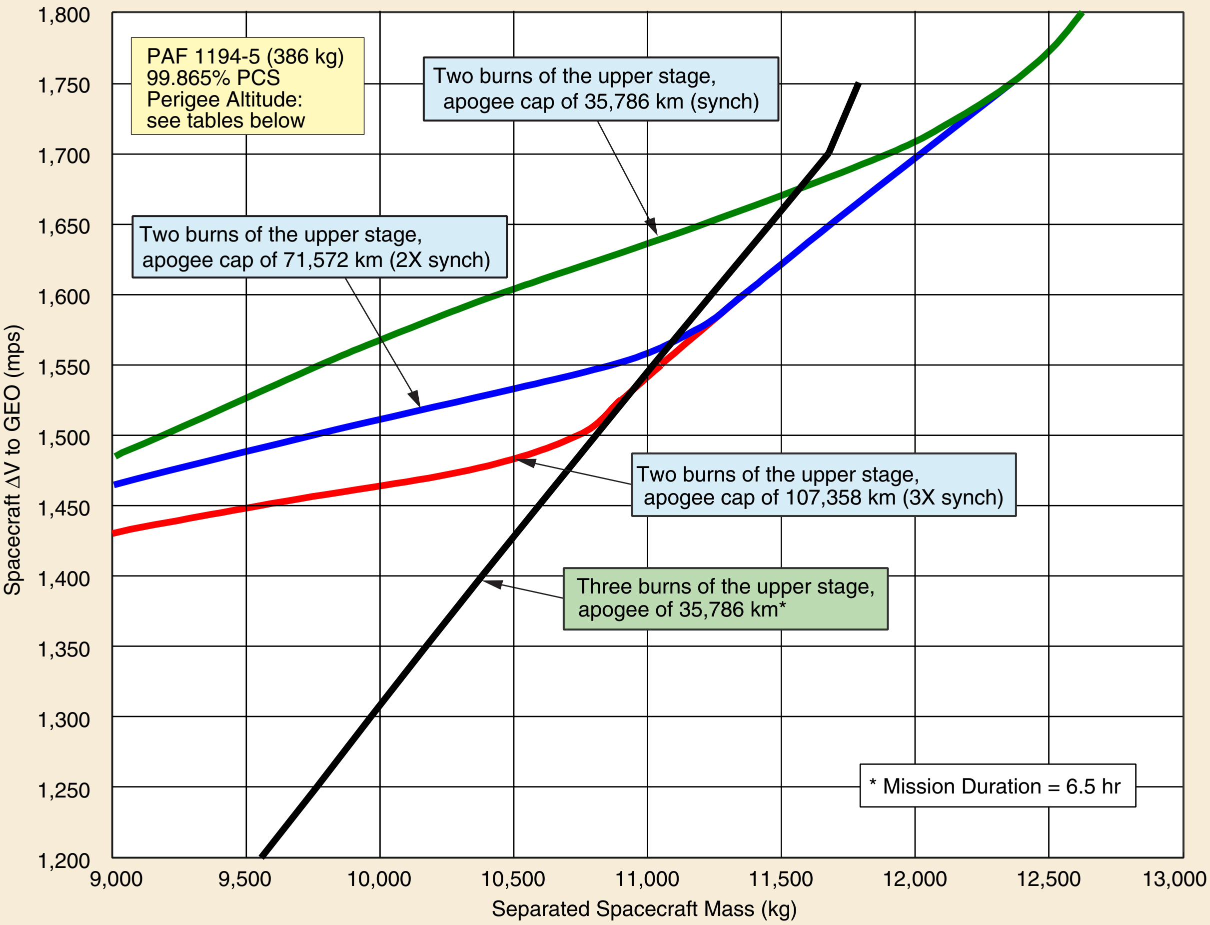

Two-Burn Apogee Cap = 35,786 km (Synch)	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,800 m/sec	237 x 35,786 km at 27.0 deg
1,750 m/sec	241 x 35,786 km at 24.6 deg
1,700 m/sec	252 x 35,786 km at 22.1 deg
1,650 m/sec	274 x 35,786 km at 19.4 deg
1,600 m/sec	780 x 35,786 km at 18.9 deg
1,550 m/sec	1,418 x 35,786 km at 18.8 deg
1,500 m/sec	1,840 x 35,786 km at 17.7 deg
1,450 m/sec	2,120 x 35,786 km at 16.1 deg

Two-Burn Apogee Cap = 71,572 km (2X Synch)	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,750 m/sec	241 x 35,786 km at 24.6 deg
1,700 m/sec	246 x 43,736 km at 25.4 deg
1,650 m/sec	250 x 53,727 km at 26.0 deg
1,600 m/sec	254 x 67,137 km at 26.6 deg
1,550 m/sec	267 x 71,572 km at 23.3 deg
1,500 m/sec	654 x 71,572 km at 20.0 deg
1,450 m/sec	1,593 x 71,572 km at 19.4 deg
1,400 m/sec	2,257 x 71,572 km at 17.3 deg

Two-Burn Apogee Cap = 107,358 km (3X Synch)	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,600 m/sec	254 x 67,149 km at 26.6 deg
1,550 m/sec	257 x 85,692 km at 27.1 deg
1,500 m/sec	262 x 107,358 km at 26.5 deg
1,450 m/sec	503 x 107,358 km at 20.4 deg
1,400 m/sec	1,774 x 107,358 km at 19.3 deg

Three-Burn Apogee = 35,786 km	
Spacecraft ΔV to GEO	Orbit Perigee Altitude by Apogee Altitude at Inclination
1,750 m/sec	803 x 35,786 km at 26.3 deg
1,700 m/sec	850 x 35,786 km at 24.2 deg
1,650 m/sec	1,139 x 35,786 km at 22.7 deg
1,550 m/sec	1,902 x 35,786 km at 20.4 deg
1,500 m/sec	2,321 x 35,786 km at 19.3 deg
1,450 m/sec	2,754 x 35,786 km at 18.2 deg
1,400 m/sec	3,217 x 35,786 km at 17.2 deg
1,350 m/sec	3,701 x 35,786 km at 16.2 deg
1,300 m/sec	4,231 x 35,786 km at 15.3 deg
1,250 m/sec	4,773 x 35,786 km at 14.4 deg

Figure 2-41. Delta IV Heavy GTO Performance Capability

2.2.4 Delta IV Heavy Dual-Manifest GTO Mission Profile (Supplemental Information)

The baseline dual-manifesting approach enables two payloads to be launched into GTO on a single Delta IV Heavy vehicle. The sequence of events through upper spacecraft separation for the dual-manifest Delta IV Heavy is shown in Figure 2-4A. The standard two-burn dual-manifest delivery orbit is 271-km perigee by 71,572-km apogee at 23.3 deg of inclination to geosynchronous transfer orbit (GTO). This baseline drop-off orbit, with an apogee altitude capped at twice-synchronous altitude, will deploy both satellites into an orbit that requires a satellite ΔV to GEO of approximately 1,550 m/sec. The total mission duration for satellite deployment into the proposed standard delivery orbit is approximately 1.5 hours from liftoff through final spacecraft separation.

Figure 2-8 shows the dual-manifest deployment sequence. During the ascent phase, the 5-m-dia fairing is jettisoned once the free-molecular heating rate has reached a specified level. This exposes the satellite in the upper bay, while the satellite in the lower bay remains encapsulated within DPAF-5. The Delta IV second stage then maneuvers into the intended delivery orbit at the attitude required for separation of the upper payload. Following the events of the second stage, the

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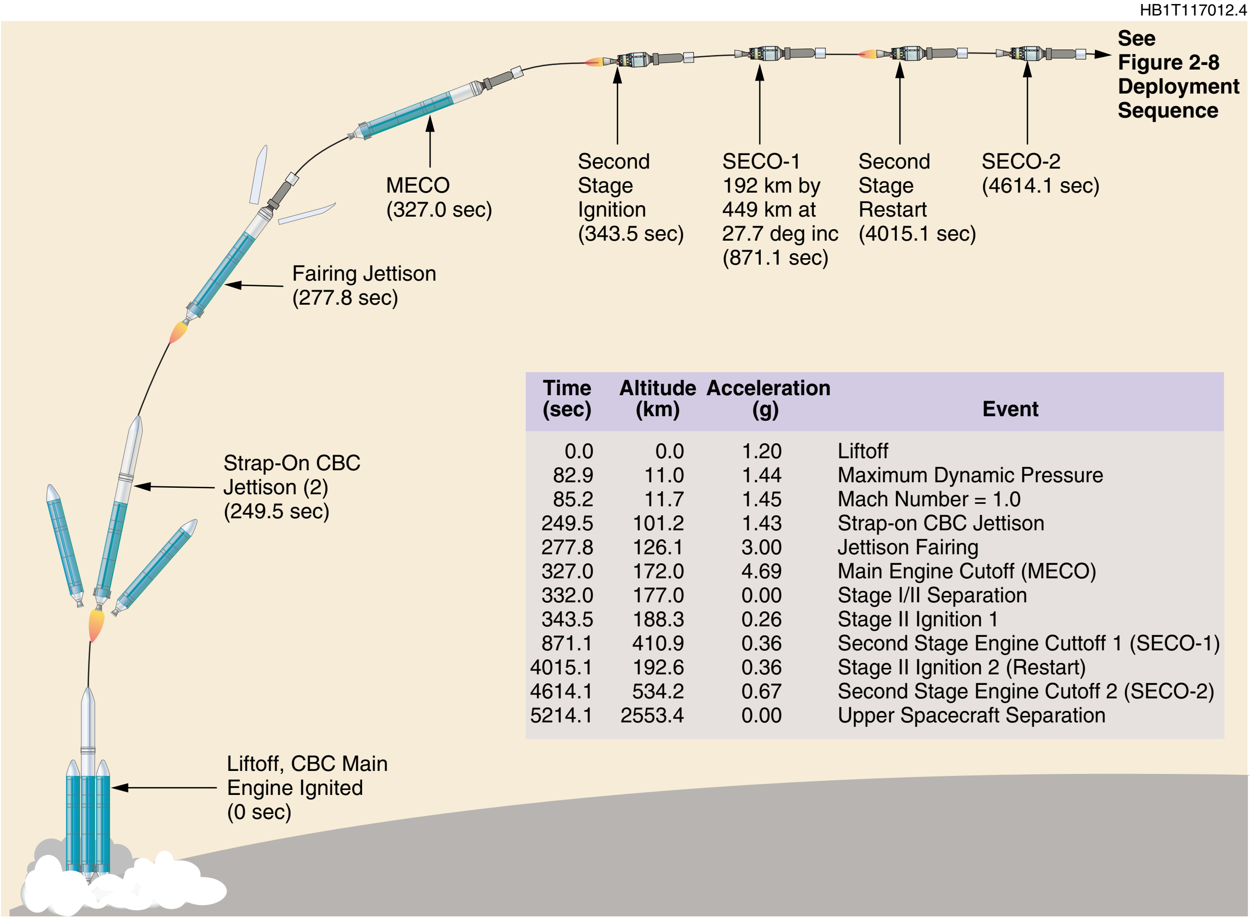

Time (sec)	Altitude (km)	Acceleration (g)	Event
0.0	0.0	1.20	Liftoff
82.9	11.0	1.44	Maximum Dynamic Pressure
85.2	11.7	1.45	Mach Number = 1.0
249.5	101.2	1.43	Strap-on CBC Jettison
277.8	126.1	3.00	Jettison Fairing
327.0	172.0	4.69	Main Engine Cutoff (MECO)
332.0	177.0	0.00	Stage I/II Separation
343.5	188.3	0.26	Stage II Ignition 1
871.1	410.9	0.36	Second Stage Engine Cuttoff 1 (SECO-1)
4015.1	192.6	0.36	Stage II Ignition 2 (Restart)
4614.1	534.2	0.67	Second Stage Engine Cutoff 2 (SECO-2)
5214.1	2553.4	0.00	Upper Spacecraft Separation

Figure 2-4A. Delta IV Heavy Dual-Manifest Sequence of Events for a GTO Mission (Eastern Range)

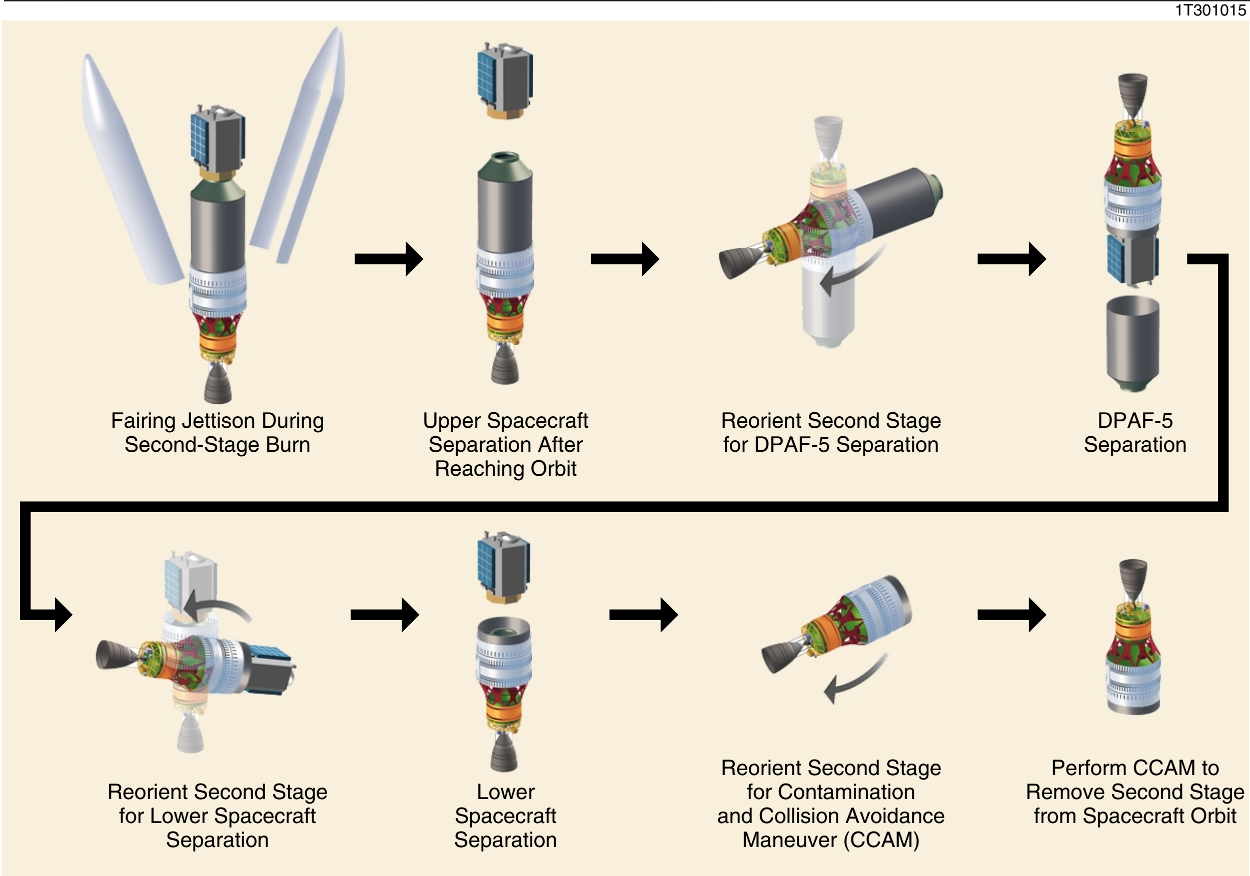

Figure 2-8. Delta IV Heavy Dual-Manifest Spacecraft Deployment Sequence

upper payload is released, and then the second stage performs a reorientation maneuver. Once this maneuver is completed, the DPAF-5 canister is deployed over the top of the lower payload, in a direction that will assure no contact with the lower satellite and no interference with the upper satellite that was already deployed.

After the DPAF-5 structure has been released, the second stage reorients itself again into the attitude required for separation of the lower spacecraft. Once the lower satellite has been deployed successfully, the second stage performs an additional reorientation maneuver, and executes a contamination and collision avoidance maneuver (CCAM). This assures that the second stage will not contaminate or interfere with the released satellites.

Satellite separation can be accomplished using three-axis stabilization, spin stabilization, or transverse tip-off modes. A separation analysis is conducted to assure proper payload separation with no contamination or interference as a result of the other satellite, DPAF-5 structure, or launch vehicle second stage. Please contact BLS for specific mission analysis.

2.2.6 C_3 Performance (Supplemental Information)

For interplanetary and other high-energy missions, the Delta IV family provides launch vehicles that enable the satellite to escape the Earth's gravitational field. Table 2-5 contains a summary listing of C_3 performance for the Delta IV family of launch vehicles. Additional C_3 performance is available by incorporating a Star 48B third stage. This is the same flight-proven third stage that has flown numerous times on Delta II for interplanetary missions. For optimization to support a specific interplanetary or high-energy mission, please contact BLS.

Table 2-5. Delta IV C_3 Performance Summary

C_3 (km^2/sec^2)	Separated Spacecraft Mass (kg (lb))			
	Delta IV Medium	**Delta IV-M+ (4,2)**	**Delta IV-M+ (5,4)**	**Delta IV Heavy**
0	2,735 (6,030)	4,075 (8,985)	4,583 (10,105)	9,306 (20,519)
5	2,417 (5,329)	3,661 (8,072)	4,121 (9,086)	8,545 (18,841)
10	2,117 (4,668)	3,278 (7,228)	3,686 (8,127)	7,812 (17,225)
15	1,833 (4,042)	2,922 (6,443)	3,279 (7,230)	7,107 (15,670)
20	1,567 (3,455)	2,592 (5,715)	2,898 (6,390)	6,436 (14,191)
25	1,319 (2,908)	2,285 (5,038)	2,540 (5,600)	5,809 (12,808)
30	1,086 (2,895)	1,995 (4,399)	2,205 (4,862)	5,228 (11,527)
35	868 (1,914)	1,723 (3,799)	1,884 (4,154)	4,691 (10,343)
40	664 (1,464)	1,470 (3,241)	1,583 (3,490)	4,192 (9,243)
45	473 (1,043)	1,233 (2,719)	1,300 (2,866)	3,729 (8,222)
50	293 (646)	1,012 (2,231)	1,035 (2,282)	3,298 (7,272)
60	0 (0)	610 (1,345)	550 (1,213)	2,521 (5,559)

Notes:
(1) Assumes a 99.865% PCS, two-stage vehicle
(2) Values based on vehicle performance only. Shaded regions indicate further structural analysis may be required for lighter payloads.

Section 3 (Update)
PAYLOAD FAIRINGS

3.2 4-M AND 5-M-DIA COMPOSITE PAYLOAD FAIRING (REVISE LAST PARAGRAPH, REPLACE FIGURES 3-9 AND 3-10)

The dual-manifest payload accommodations, shown in Figures 3-9 and 3-10 feature a dual-payload attach fitting (DPAF) that encapsulates the lower payload and then serves as structure support for the upper payload. The payload is then encapsulated by the 19.1-m fairing that also is used by the Delta IV Heavy. Both payloads are mounted within these bays to Delta IV separation interfaces, dependent on payload needs. Two configurations of the DPAF have been created to meet customer needs. These figures also assume that the payload stiffness guidelines in Section 4.2.3 are observed. Protrusion outside any portion of the payload envelope or below the payload separation plane require coordination with and approval of Boeing Launch Services.

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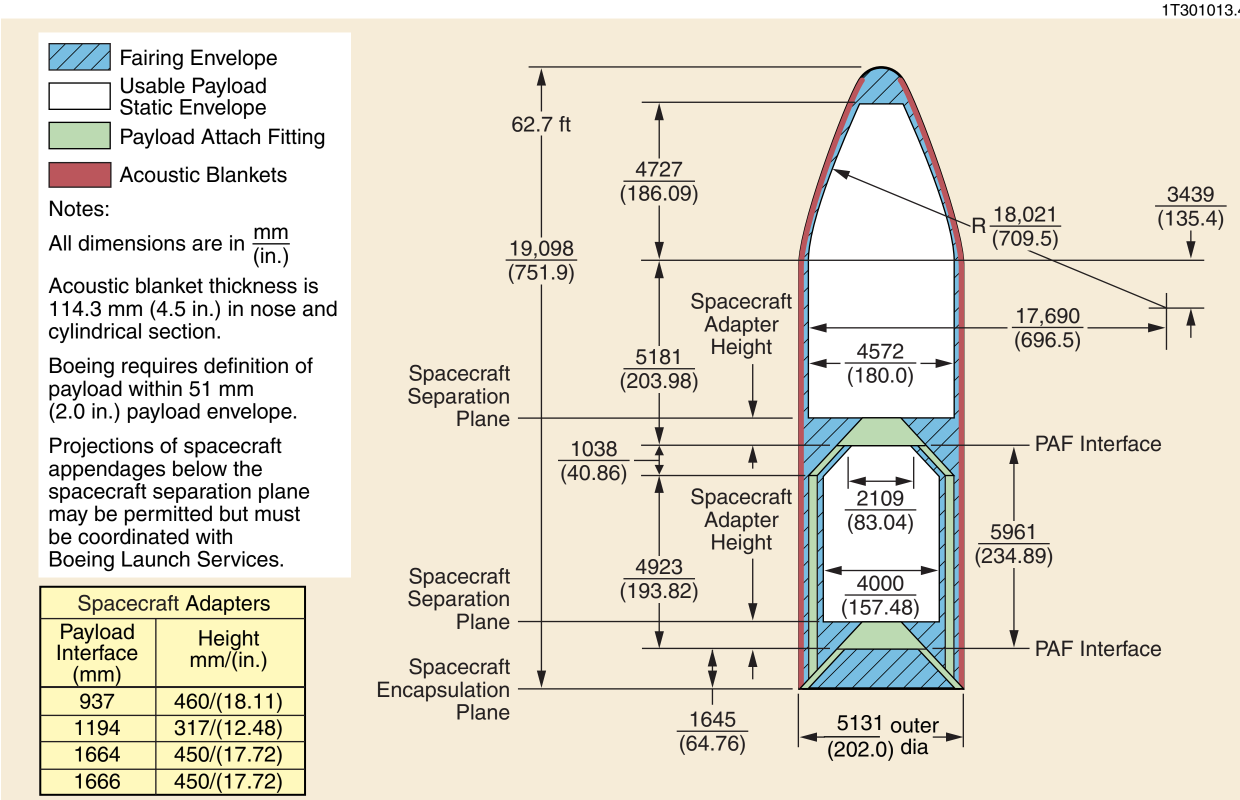


Spacecraft Adapters	
Payload Interface (mm)	Height mm/(in.)
937	460/(18.11)
1194	317/(12.48)
1664	450/(17.72)
1666	450/(17.72)

Figure 3-9. Delta IV Heavy Dual Manifest (DPAF-5 Long)

1T301014.4

Fairing Envelope
Usable Payload Static Envelope
Payload Attach Fitting
Acoustic Blankets

Notes:

All dimensions are in mm/(in.)

Acoustic blanket thickness is 114.3 mm (4.5 in.) in nose and cylindrical section.

Boeing requires definition of payload within 51 mm (2.0 in.) payload envelope.

Projections of spacecraft appendages below the spacecraft separation plane may be permitted but must be coordinated with Boeing Launch Services.

Spacecraft Adapters	
Payload Interface (mm)	Height mm/(in.)
937	460/(18.11)
1194	317/(12.48)
1664	450/(17.72)
1666	450/(17.72)

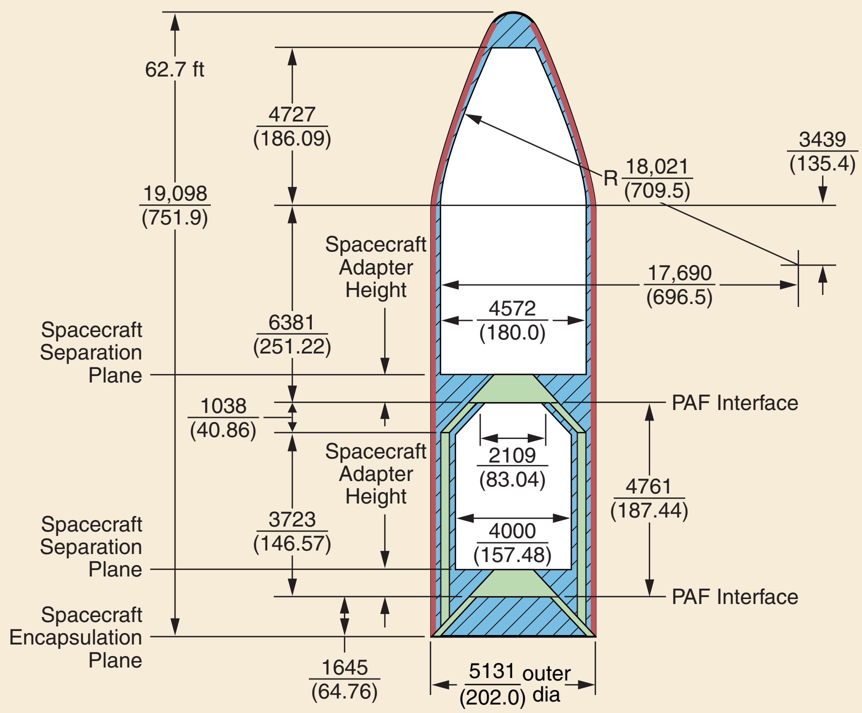
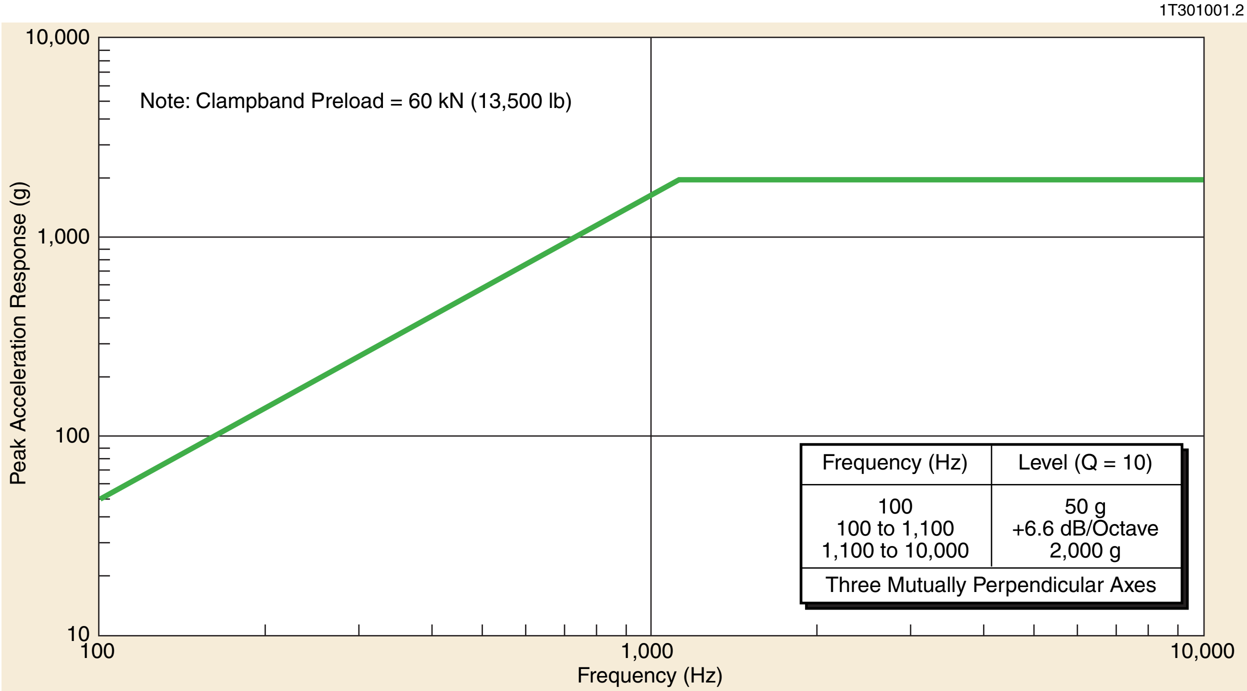


Figure 3-10. Delta IV Heavy Dual Manifest (DPAF-5 Short)

Section 4 Update
PAYLOAD ENVIRONMENTS

4.2.3.5 Shock Environment (Supplemental Information)

4.2.3.5.2 Low-Shock Separation System. To meet the ever-increasing mass of today's commercial satellites, Delta and Sea Launch, along with Saab Aerospace, are developing a low-shock separation system for satellites featuring an 1194-mm interface, for both 4-m and 5-m applications, which will be available for flights beginning in mid-2003. Designated the 1194VS, the low-shock separation system is designed to accommodate satellites weighing up to 8 metric tonnes (17,632 lb) and requiring clampband preloads up to 60 kN (13,500 lb). The only significant difference from the current Saab 1194 separation system is the release device. The 1194VS uses a separation system based on a nonexplosive design known as the fast-acting shock separation nut (FASSN), which has been used successfully on a classified U.S. government satellite. The 1194VS currently is undergoing a full qualification test program by Saab, the world's most experienced maker of satellite separation systems. A 100% success rate has been achieved on the approximately 270 Saab satellite separation systems flown to date. A preliminary estimate of the maximum shock environment with the new separation system is shown in Figure 4-35 for the Delta IV family of launch vehicles.



Frequency (Hz)	Level (Q = 10)
100 100 to 1,100 1,100 to 10,000	50 g +6.6 dB/Octave 2,000 g
Three Mutually Perpendicular Axes	

Figure 4-35. Launch-Vehicle-Induced Payload Interface Shock Environment (95th Percentile, 50% Confidence)—1194VS-4, -5 Payload Attach Fittings

As part of our continual evolution to meet our customers' needs, we will be introducing additional low-shock separation systems to support other spacecraft interfaces at a later date.

4.2.5 Dynamic Analysis Criteria and Balance Requirements (Table 4-13 Upated)

Typical payload separation attitude and rate dispersions are shown in Table 4-13. Dispersions are defined for each vehicle configuration and consist of all known error sources. Dispersions are affected by spacecraft mass properties and center of gravity (CG) offsets. Mission-specific attitude and rate dispersions are defined in the payload/expended stage separation analysis.

Table 4-13. Typical Payload Separation Attitudes/Rates

			Payload separation attitude and rate dispersions (3-σ values)	
Configuration	**Spinning**	**PAF**	**Attitude (deg)**	**Rate (dps)**
Two stage	No	1194-5 1194-4 1575-4 1664-4 1664-5 1666-4 1666-5	<1.40	<2.0 (trans), <1.0 (roll)
	Up to 5 rpm (±1 deg/sec)	1194-4	<10.0	<3.0 (transverse)

Note: Enhanced attitude pointing capability for spinning missions is currently under study with a goal of achieving attitude pointing errors less than 1.75 deg.

Section 6 Update
LAUNCH OPERATION AT EASTERN RANGE

6.2.1.9 Astrotech Building 9 (Delta IV Payload Processing Facility for Dual-Manifest Missions) (Supplemental Information). Delta IV dual-manifest payloads will be processed for dual-manifest missions at Astrotech Space Operations (ASO) facilities in Titusville, Florida. To address the increased demands of 5-m satellite processing, Astrotech recently has constructed a new payload processing facility—Building 9.

ASO Building 9 is designed to accommodate concurrent operations involving multiple customers through the use of the two spacecraft processing cells: the encapsulation bay and associated support areas. Facility occupancy assignments will be based on the configuration of the dual-manifest mission (e.g., multiple small satellites, two large satellites, single vs. multiple customers, etc.). During the mission-integration process, Boeing will coordinate all activities with ASO to assure the availability of the facilities required to support the customer's mission requirements. Encapsulation of customer payloads with the dual-manifest system will begin 13 days before launch. Our process for integrating payloads with the dual-manifest system is shown in Figure 6-12A.

Once a satellite has completed its preparations within the ASO processing facility, each payload will be mated to its assigned spacecraft adapter for spacecraft checkout. Payload "stack-up" begins by mounting the lower spacecraft and spacecraft adapter combination to the base payload attach fitting. A verification test will be performed to assure that all connections are properly mated and all systems are functioning. When these tests are completed, the DPAF-5 canister is placed over the lower payload and mated to the base payload attach fitting.

In parallel to the lower payload encapsulation, the upper payload is mated to its assigned spacecraft adapter. Once the lower payload is encapsulated within DPAF-5, the upper payload and its spacecraft adapter are transferred into the high bay and mated to the top of DPAF-5. A verification test is then performed for the upper payload to assure that all connections are properly mated and all systems are functioning properly.

Once the stack-up is completed, the dual-manifested payloads will be encapsulated within the 5-m-dia., 19.1-m (62.7-ft)-long composite fairing. After encapsulation is completed, conditioned air is provided through two ports in the fairing, one to each payload compartment, to assure a contamination-free and thermally stabilized environment. Conditioned air is provided as the encapsulated payloads are transported to the launch pad approximately 5 days before launch. At the Delta IV launch pad, the encapsulated satellites are hoisted by the mobile service tower (MST) crane and mated to the top of the Delta IV Heavy second stage. Final connections are verified, and preparations are made for final countdown and launch. Conditioned air is provided to each payload bay on pad through the same two ports in the fairing until launch.

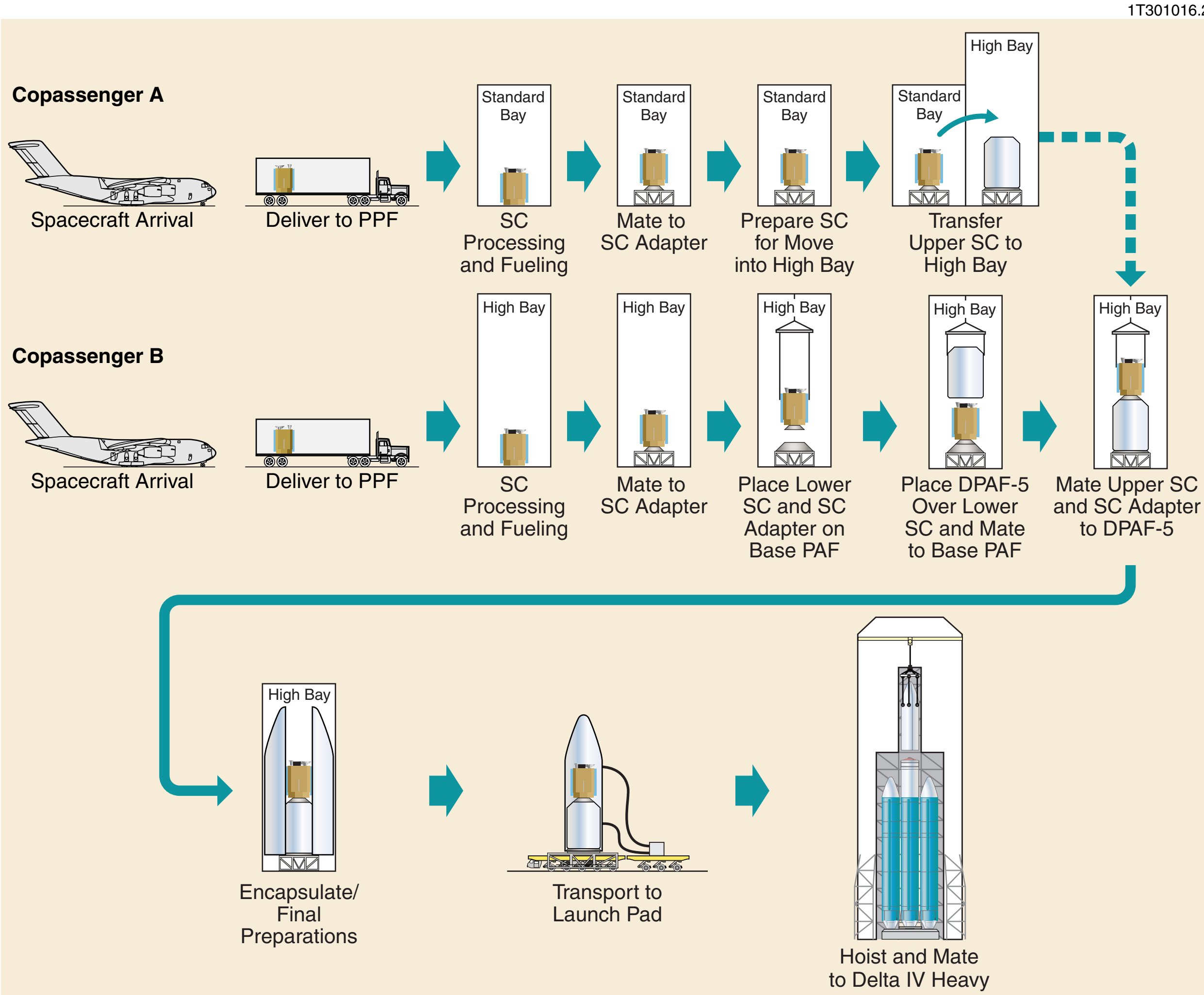


Figure 6-12A. Dual-Manifest Payload Processing and Encapsulation

BLS and ASO protect the proprietary nature of your satellite and assure security through non-disclosure agreements and proprietary information agreements. Each payload will be assigned a specific mission integration manager who will coordinate all launch campaign activities and assure that sensitive information is not shared between companies. Spacecraft personnel will not have access to each other's satellites, even during spacecraft mating to the dual-manifest system.

6.4.1 Mobile Service Tower (MST) (Supplemental Information)

The work platforms on levels 5 through 7 provide a weather-protected area for launch vehicle interstage access. The work platforms on levels 8 through 12 provide a weather-protected, climate-controlled area for upper-stage and payload checkout. There is a payload users room located on level 8 that customers can use to house electrical ground support equipment. This room is 3.05 by 6.10 m by 4.12 m high (10 ft by 20 ft by 12.5 ft high) with a 0.88-m by 2.1-m (2.9-ft by 6.9-ft) door. The room can support a floor loading of 244 kg/m^2 (50 lb/ft^2) and point loading of 907.2 kg (2000 lb) distributed over a 0.76-m by 0.760m (2.5-ft by 2.5-ft) area. The work platform floor plan for level 8 is shown in Figure 6-19. The movable work platform floor plans for levels 9 through 12 are shown in Figures 6-20 and 6-21.

Physical access to dual-manifested payloads is possible until approximately 24 hours before launch. Access doors will be provided at agreed-to locations in the fairing and DPAF-5 to allow customers access to their satellite systems after encapsulation. Access to the different payload user rooms (on MST level 8 and MST level 10) will be controlled via electronic badge readers that allow only authorized, properly trained personnel to gain entry to that payload level.

Section 8 Update (replaces pages 8-1 through 8-9 and 8-21)
PAYLOAD INTEGRATION

This section describes the payload integration process (18-month baseline) and the supporting documentation requirements.

8.1 INTEGRATION PROCESS (Figure 8-1 deleted)

The integration process developed by Boeing is designed to support the payload requirements as well as the requirements of the launch vehicle. In working with our customers, we have continuously improved our integration process, and now offer an 18-month mission integration cycle as our baseline. Boeing will continue to work with customers to tailor the integration flow to meet their individual program requirements. The typical integration process encompasses the entire cycle of launch vehicle/payload integration activities; L-date is defined as calendar weeks, including workdays and scheduled non-workdays, such as holidays. At its core is a streamlined series of documents, reports, and meetings that are flexible and adaptable to the specific requirements of each program.

Mission integration for commercial and government missions is the responsibility of the Delta Program Office located at the Boeing facility in Huntington Beach, California. The objective of mission integration is to coordinate all interface activities required for a successful launch, including the development of a mission specification, interface planning, coordination, and scheduling.

The Delta Program team assigns a mission integration manager to work with the customer and coordinate all mission-related interface activities. The mission integration manager develops a mission-specific integration planning schedule for both the launch vehicle and the payload by defining the documentation and analysis required. The mission integration manager also synthesizes payload requirements, engineering design, and launch environments into a controlled mission specification that establishes and documents all agreed-to interface requirements.

The mission integration manager ensures that all lines of communication function effectively. To this end, all pertinent communications, including technical/administrative documentation, technical interchange meetings (TIM), and formal integration meetings are coordinated by the mission integration manager. These lines of communication exist not only between the customer and Boeing, but also include other agencies involved in the Delta IV launch. Figure 8-2 illustrates the relationships among agencies involved in a typical Delta IV mission.

8.2 DOCUMENTATION

Effective integration of the payload into the Delta IV launch system requires diligent, timely preparation and submittal of required documents. When submitted, these documents represent the

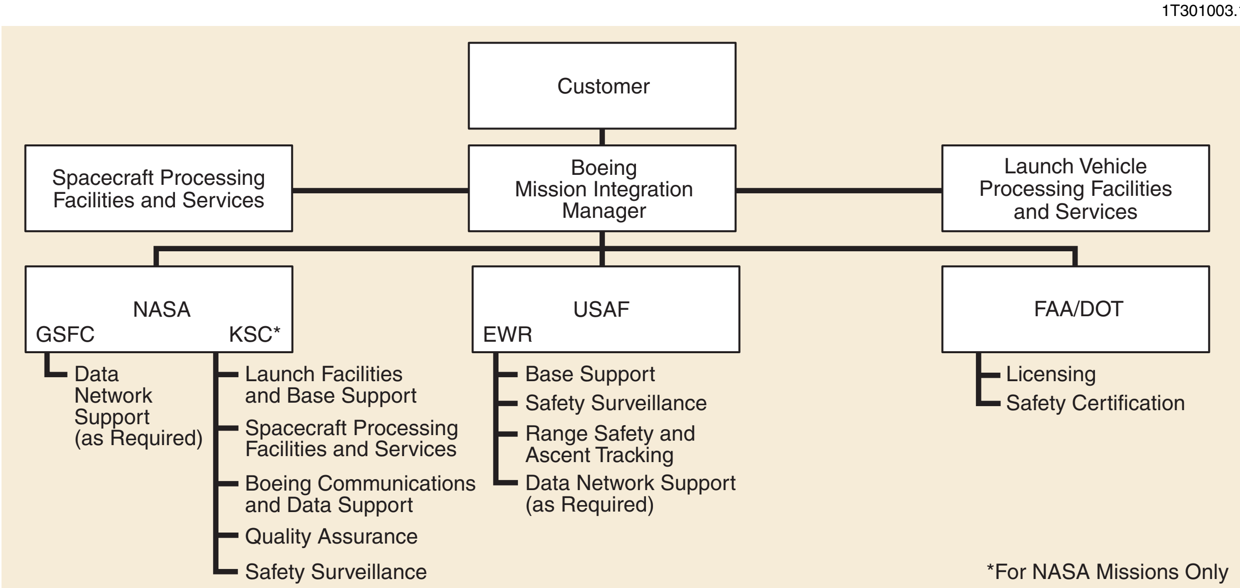


Figure 8-2. Typical Delta IV Agency Interfaces

primary communication of requirements, safety provisions, and system descriptions to each of the launch support agencies. The Delta Program Office acts as the administrative interface to assure proper documentation has been provided to the appropriate agencies. All formal and informal data are routed through this office. Relationships of the various categories of documentation are shown in Figure 8-3.

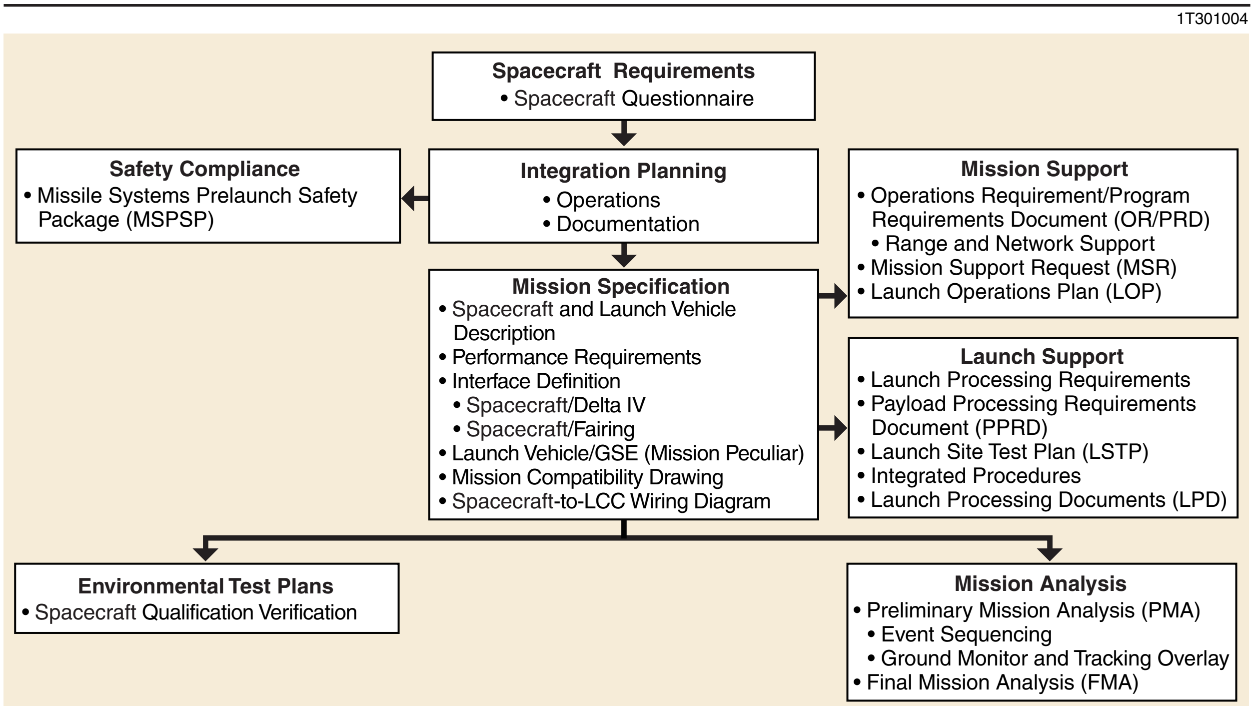


Figure 8-3. Typical Document Interfaces

A typical integration planning schedule is shown in Figure 8-4. Each data item listed in Figure 8-4 has an associated L-date (weeks before launch). The party responsible for each data item is identified. Close coordination with the Delta IV mission integration manager is required to achieve successful planning of integration documentation.

The required documents for a typical mission are listed in Tables 8-1 and 8-2. Table 8-3 describes the contents of the program documents identified. Mission-specific schedules are established by agreement with the customer. The Spacecraft Questionnaire shown in Table 8-4 is normally completed by the payload agency 78 weeks prior to launch to provide an initial definition of payload characteristics and requirements. A spacecraft interface requirements document (IRD) or launch services requirements document (LSRD) may be used instead of the questionnaire. Table 8-5 is an outline of a typical payload launch-site test plan describing the launch site activities and operations expected in support of the mission. A set of orbital elements as described in Table 8-6 is requested from the spacecraft customer to reconstruct the performance of the launch vehicle.

8.3 LAUNCH OPERATIONS PLANNING

Development of launch operations, range support, and other support requirements is an evolutionary process that requires timely inputs and continued support from the customer.

8.4 PAYLOAD PROCESSING REQUIREMENTS

The checklist shown in Table 8-7 is provided to assist the customer in identifying the requirements at each processing facility. The requirements identified are submitted to Boeing for the program requirements document (PRD) and payload processing requirements document (PPRD). Boeing coordinates with the range and payload processing facility, and implements the requirements through the PRD/PPRD. The customer may add items to the list.

1T301006.6

Task Name	OPR	Due Date (Wks)	Months From Launch																			
			-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1
1. Spacecraft Questionnaire/IRD/LSRD	C	L-78	▲																			
2. Fairing Requirements	C	L-78	▲																			
3. SC Drawings (Initial)	C	L-78	▲																			
4. SC Mathematical Model (Initial)	C	L-78	▲																			
5. MSPSP Inputs (Initial)	C	L-68			▲																	
6. Separation Analysis (Initial)	B	L-68			▲																	
7. Mission Specification (Initial)	B	L-65			▲																	
8. SC-to-Control Ctr Wiring Requirements	C	L-65				▲																
9. Preliminary Mission Analysis (PMA) Rqmts	C	L-65				▲																
10. SC Mass Properties Statement (Initial)	C	L-65				▲																
11. Mission Specification Comments	C	L-61				▲																
12. SC Environmental Test Document (Test Plan)	C	L-58					▲															
13. Coupled Dynamic Loads Analysis (FDLC)	B	L-58					▲															
14. SC Compatibility Drawing (Draft)	B	L-58					▲															
15. SC Compatibility Drawing Comments	C	L-56						▲														
16. Radio Frequency Applications Inputs	C	L-52							▲													
17. Preliminary Mission Analysis	B	L-52							▲													
18. SC Compatibility Drawing (Initial)	B	L-52							▲													
19. Program Requirements Document - SC Inputs	C	L-52							▲													
20. Spacecraft Thermal Model (Initial)	C	L-52							▲													
21. Mission Operations and Support Requirements	C	L-52							▲													
22. P/L Processing Requirements Document Inputs	C	L-52							▲													
23. SC-to-Control Center Wiring Diagram (Initial)	B	L-52							▲													
24. MSPSP Inputs (Interim)	C	L-52							▲													
25. DOT License Information	C	L-50							▲													
26. SC Mass Properties Statement (Update)	C	L-46								▲												
27. DOT License Application	B	L-46								▲												
28. Final Mission Analysis (FMA) Requirements	C	L-46								▲												
29. Launch Window (Initial)	C	L-46								▲												
30. SC Mathematical Model (Final)	C	L-42									▲											
31. SC Drawings (Final)	C	L-40									▲											
32. SC Ctrl Ctr Wiring Diagram Comments	C	L-39										▲										
33. Payload Processing Requirements Document	B	L-39										▲										
34. Thermal Analysis Report (Preliminary)	B	L-39										▲										
35. Launch Vehicle Insignia	C	L-38										▲										
36. SC Environmental Test Report	C	L-33											▲									
37. SC Thermal Model (Final)	C	L-33											▲									
38 Final Mission Analysis (FMA)	B	L-32											▲									
39. SC Compatibility Drawing (Final)	B	L-30												▲								
40. SC-to-Control Center Wiring Diagram (Final)	B	L-26													▲							
41. Thermal Analysis Report (Final)	B	L-26													▲							
42. MSPSP Inputs (Final)	C	L-26													▲							
43. Program/Operations Requirements Document (PRD/ORD)	B	L-26													▲							
44. Coupled Dynamic Loads Analysis (VLC)	B	L-24														▲						
45. Mission Specification (Final)	B	L-21														▲						
46. SC Launch Site Procedures	C	L-20														▲						
47. SC Integrated Test Procedure Inputs	C	L-20														▲						
48. SC Clearance Drawing	B	L-20														▲						
49. SC Mass Properties Statement (Final, Predicted)	C	L-20														▲						
50. RF Compatibility Analysis Report	B	L-19														▲						
51. MSPSP (Final)	B	L-17															▲					
52. SC Separation Analysis (Final)	B	L-15															▲					
53. Integrated Countdown Schedule	B	L-13																▲				
54. Launch Site Integrated Procedures	B	L-13																▲				
55. Launch Window (Final)	C	L-04																			▲	
56. Launch Operations Plan (LOP)	B	L-04																			▲	
57. Vehicle Information Memorandum (VIM) Input	C	L-04																			▲	
58. Best-Estimate Trajectory	B	L-02																			▲	
59. Launch Readiness Review Data Package	B	L-1 day																			▲	
60. Launch	B	L-0																			▲	
61. Post-Launch Report Orbit Confirmation Data	C	L+1 day																				▲
62. Post-Launch Report (Final)	B	L+8																				▲

B = Boeing
C = Customer

Figure 8-4. 18-Month Nominal Integration Planning Schedule

BOEING

Table 8-1. Customer Data Requirements

Description	Table 8-3 reference	Nominal due weeks - or + launch
Spacecraft Questionnaire	2	L-78
Fairing Requirements	8	L-78
SC Drawings (Initial/Final)	18	L-78/L-40
SC Mathematical Model (Initial/Final)	3	L-78/L-42
Missile System Prelaunch Safety Package SC Inputs (Initial/Update/Final)	9	L-68/L-52/L-26
Electrical Wiring Requirements	7	L-65
Preliminary Mission Analysis (PMA) Inputs	11	L-65
SC Mass Properties Statement (Initial/Update/Final)	22	L-65/L-46/L-20
SC Environmental Test Documents	5	L-58
SC Compatibility Drawing Comments	18	L-56
Radio Frequency Applications Inputs	10	L-52
Mission Operational and Support Requirements	12	L-52
Payload Processing Requirements Document Inputs	14	L-52
Program Requirements Document Inputs	13	L-52
DOT License Information	2	L-50
Final Mission Analysis (FMA) Inputs	17	L-46
Launch Window (Initial/Final)	16	L-46/L-04
SC-to-LCC Wiring Diagram Review	28	L-39
Launch Vehicle Insignia	15	L-38
Spacecraft Environments and Loads Test Report	5	L-33
Mission Specification Comments	4	30 days after receipt
Spacecraft Launch Site Test Plan	19	L-20
SC Integrated Test Procedure Inputs	21	L-20
SC Launch-Site Procedures	20	L-20
VIM Input	26	L-4
Postlaunch Orbit Confirmation Data	27	L+1 day

0000575.15

Table 8-2. Boeing Program Documents

Description	Table 8-3 reference	Nominal due weeks - or + launch
SC Separation Analysis (Initial/Final)	24	L-68/L-15
Mission Specification (Initial/Final)	4	L-65/L-21
Coupled Dynamic Loads Analysis (FDLC/VLC)	6	L-58/L-24
Preliminary Mission Analysis (PMA)	11	L-52
Payload Processing Requirements Document (PPRD)	14	L-39
Final Mission Analysis (FMA)	17	L-32
SC Compatibility Drawing (Final)	18	L-30
SC-to-LCC Wiring Diagram (Final)	28	L-26
Program Requirements Document /Operations Requirements Document	14	L-26
SC-Fairing Clearance Drawing	18	L-20
RF Compatibility Analysis	23	L-19
MSPSP	9	L-17
Integrated Countdown Schedule	30	L-13
Launch Site Integrated Procedures	29	L-13
Launch Operations Plan	25	L-4
VIM	26	L-15 days

0000576.2

Table 8-3. Required Documents

	Item	Responsibility
1.	**Feasibility Study (Optional)** A feasibility study may be necessary to define the launch vehicle's capabilities for a specific mission or to establish the overall feasibility of using the launch vehicle for performing the required mission. Typical items that may necessitate a feasibility study are (1) a new flight plan with unusual launch azimuth or orbital requirements, (2) a precise accuracy requirement or a performance requirement greater than that available with the standard launch vehicle, and (3) a payload that imposes uncertainties with respect to launch vehicle stability. Specific tasks, schedules, and responsibilities are defined before study initiation, and a final report is prepared at the conclusion of the study.	Boeing
2.	**Spacecraft Questionnaire** The Spacecraft Questionnaire (Table 8-4) is the first step in the process. It is designed to provide the initial definition of spacecraft requirements, interface details, launch site facilities, and preliminary safety data for Delta's various agencies. It contains a set of questions whose answers define the requirements and interfaces as they are known at the time of preparation. The completed questionnaire is required not later than 18 months prior to launch. Additionally, the spacecraft's own IRD or LSRD may replace the questionnaire if the needed data is defined. A specific response to some questions may not be possible because many items are defined at a later date. Of particular interest are answers that specify requirements in conflict with constraints specified herein. Normally, this document is not kept current; it will be used to create the initial issue of the mission specification (Item 4) and in support of our Federal Aviation Administration (FAA)/Department of Transportation (DOT) launch permit. The specified items are typical of the data required for Delta IV missions. The spacecraft contractor is encouraged to include other pertinent information regarding mission requirements or constraints.	Customer
3.	**Spacecraft Mathematical Model for Dynamic Analysis** A spacecraft mathematical model is required for use in a coupled loads analysis. Acceptable forms include (1) a discrete math model with associated mass and stiffness matrices or (2) a constrained normal mode model with modal mass and stiffness and the appropriate transformation matrices to recover internal responses. Required model information such as specific format, degrees-of-freedom requirements, and other necessary information will be supplied.	Customer
4.	**Mission Specification** The Boeing Mission Specification functions as the Delta launch vehicle interface control document and describes all mission-specific requirements. It contains the spacecraft description, spacecraft-to-operations-building wiring diagram, compatibility drawing, targeting criteria, special spacecraft requirements affecting the standard launch vehicle, description of the mission-specific launch vehicle, a description of special aerospace ground equipment (AGE) and facilities Boeing is required to furnish. The document is provided to spacecraft agencies for review and concurrence and is revised as required. The initial issue is based on data provided in the Spacecraft Questionnaire and is provided approximately 68 weeks before launch. Subsequent issues are published as requirements and data become available. The mission-specific requirements documented in the mission specification, along with the standard interfaces presented in this manual, define the spacecraft-to-launch vehicle interface.	Boeing (input required from Customer)
5.	**Spacecraft Environmental Test Documents** The environmental test plan documents the spacecraft contractor's approach for qualification and acceptance (preflight screening) tests. It is intended to provide a general test philosophy and an overview of the system-level environmental testing to be performed to demonstrate adequacy of the spacecraft for flight (e.g., static loads, vibration, acoustics, shock). The test plan should include test objectives, test specimen configuration, general test methods, and a schedule. It should not include detailed test procedures. Following the system-level structural loads and dynamic environment testing, test reports documenting the results shall be provided to Boeing. These reports should summarize the testing performed to verify the adequacy of the spacecraft structure for the flight loads. For structural systems not verified by test, a structural loads analysis report documenting the analyses performed and resulting margins of safety should be provided to Boeing.	Customer
6.	**Coupled Dynamic Loads Analysis** A coupled dynamic loads analysis is performed to define flight loads to major launch vehicle and spacecraft structures. The liftoff event, which generally causes the most severe lateral loads in the spacecraft, and the period of transonic flight and maximum dynamic pressure, causing the greatest relative deflections between the spacecraft and fairing, are generally included in this analysis. Output for each flight event includes tables of maximum acceleration at selected nodes of the spacecraft model as well as a summary of maximum interface loads. Worst-case spacecraft-fairing dynamic relative deflections are included. Close coordination between the user and the Delta IV mission integration is essential so that the output format and the actual work schedule for the analysis can be defined.	Boeing (input required from Customer, item 3)

Table 8-3. Required Documents (Continued)

	Item	Responsibility
7.	**Electrical Wiring Requirements** The wiring requirements for the spacecraft to the launch control center (LCC) and the payload processing facilities are needed as early as possible. Section 5 lists the Delta capabilities and outlines details that must be supplied. Boeing will provide a spacecraft-to-operations-building wiring diagram based on the spacecraft requirements. It will define the hardware interface from the spacecraft to the LCC for control and monitoring of spacecraft functions after spacecraft installation in the launch vehicle. Close attention to the documentation schedule is required so that production checkout of the launch vehicle includes all of the mission-specific wiring. Any requirements for the payload processing facilities are to be furnished with the LCC information.	Customer
8.	**Fairing Requirements** Early spacecraft fairing requirements should be addressed in the questionnaire and updated in the mission specification. Final spacecraft requirements are needed to support the mission-specific fairing modifications during production. Any in-flight requirements, ground requirements, critical spacecraft surfaces, surface sensitivities, mechanical attachments, RF transparent windows, and internal temperatures on the ground and in flight must be provided.	Customer
9.	**Missile System Prelaunch Safety Package (MSPSP) (Refer to EWR 127-1 for specific spacecraft safety regulations)** To obtain approval to use the launch site facilities and resources for launch, an MSPSP must be prepared and submitted to Delta IV mission integration. The MSPSP includes a description of each hazardous system (with drawings, schematics, and assembly and handling procedures, as well as any other information that will aid in appraising the respective systems) and evidence of compliance with the safety requirements of each hazardous system. The major categories of hazardous systems are ordnance devices, radioactive material, propellants, pressurized systems, toxic materials and cryogenics, and RF radiation. The specific data required and suggested formats are discussed in Section 2 of EWR 127-1. Boeing will provide this information to the appropriate government safety offices for their approval.	Customer and Boeing
10.	**Radio Frequency (RF) Applications** The spacecraft contractor is required to specify the RF transmitted by the spacecraft during ground processing and launch intervals. An RF data sheet specifying individual frequencies will be provided. Names and qualifications are required covering spacecraft contractor personnel who will operate spacecraft RF systems. Data such as transmission frequency bandwidths, frequencies, radiated durations, and wattage will be provided. Boeing will provide these data to the appropriate range/government agencies for approval.	Customer and Boeing
11.	**Preliminary Mission Analysis (PMA)** This analysis is normally the first step in the mission-planning process. It uses the best-available mission requirements (spacecraft weight, orbit requirements, tracking requirements, etc.) and is primarily intended to uncover and resolve any unusual problems inherent in accomplishing the mission objectives. Specifically, information pertaining to launch vehicle environment, performance capability, sequencing, and orbit dispersion is presented. Parametric performance and accuracy data are usually provided to assist the user in selection of final mission orbit requirements. The orbit dispersion data are presented in the form of variations of the critical orbit parameters as functions of probability level. A covariance matrix and a trajectory printout are also included. The mission requirements and parameter ranges of interest for parametric studies are due as early as possible but in no case later than L-64 weeks. Comments to the PMA are needed no later than L-40 weeks for start of the FMA (Item 17).	Boeing (input required from Customer)
12.	**Mission Operational and Support Requirements** To obtain unique range and network support, the spacecraft contractor must define any range or network requirements appropriate to the mission and submit them to Boeing. Spacecraft contractor operational configuration, communication, tracking, and data flow are required to support document preparation and to arrange for required range support.	Customer
13.	**Program Requirements Document (PRD)** To obtain range and network support, a spacecraft PRD must be prepared. This document consists of a set of preprinted standard forms (with associated instructions) that must be completed. The spacecraft contractor will complete all forms appropriate to the mission and submit them to Boeing. Boeing will compile, review, provide comments, and, upon comment resolution, forward the spacecraft PRD to the appropriate support agency for formal acceptance.	Boeing (input required from Customer)
14.	**Payload Processing Requirements Document (PPRD)** The PPRD is prepared if commercial facilities are to be used for spacecraft processing. The spacecraft contractor is required to provide data on all spacecraft activities to be performed at the commercial facility. This includes detailed information on all facilities, services, and support requested by Boeing to be provided by the commercial facility. Spacecraft hazardous systems descriptions shall include drawings, schematics, summary test data, and any other available data that will aid in appraising the respective hazardous system. The commercial facility will accept spacecraft ground operations plans and/or MSPSP data for the PPRD.	Boeing (input required from Customer)

Table 8-3. Required Documents (Continued)

	Item	Responsibility
15.	**Launch Vehicle Insignia** The customer is entitled to have a mission-specific insignia placed on the launch vehicle. The customer will submit the proposed design to Boeing not later than 9 months before launch for review and approval. Following approval, Boeing will have the flight insignia prepared and placed on the launch vehicle. The maximum size of the insignia is 4.7 m by 4.7 m (15 ft by 15 ft). The insignia is placed on the uprange side of the launch vehicle.	Customer
16.	**Launch Window** The spacecraft contractor is required to specify the maximum launch window for any given day. Specifically, the window opening time (to the nearest minute) and the window closing time (to the nearest minute) are to be specified. This final window data should extend for at least 4 weeks beyond the scheduled launch date. Liftoff is targeted to the specified window opening.	Customer
17.	**Final Mission Analysis (FMA) Report** Boeing will issue an FMA trajectory report that provides the mission reference trajectory. The FMA contains a description of the flight objectives, the nominal trajectory printout, a sequence of events, vehicle attitude rates, spacecraft and launch vehicle tracking data, and other pertinent information. The trajectory is used to develop mission targeting constants and represents the flight trajectory. The FMA will be available at L-26 weeks.	Boeing (input required from Customer)
18.	**Spacecraft Drawings** Spacecraft configuration drawings are required as early as possible. The drawings should show nominal and worst-case (maximum tolerance) dimensions and a tabulated definition of the physical location of all points on the spacecraft that are within 51 mm (2 in.) of the allowable spacecraft envelope for the compatibility drawing prepared by Boeing, clearance analysis, fairing compatibility, and other interface details. Spacecraft drawings are desired with the Spacecraft Questionnaire. The drawings should be 0.20 scale and transmitted via CAD media. Details should be worked out through Delta IV mission integration.	Customer
	Boeing will prepare and release the spacecraft compatibility drawing that will become part of the mission specification. This is a working drawing that identifies spacecraft-to-launch-vehicle interfaces. It defines electrical interfaces; mechanical interfaces, including spacecraft-to-PAF separation plane, separation springs and spring seats, and separation switch pads; definition of stay-out envelopes, both internal and external to the PAF; definition of stay-out envelopes within the fairing; and location and mechanical activation of spring seats. The spacecraft contractor reviews the drawing and provides comments, and upon comment resolution and incorporation of the final spacecraft drawings, the compatibility drawing is formally accepted as a controlled interface between Boeing and the spacecraft agency. In addition, Boeing will provide a worst-case spacecraft-fairing clearance drawing.	Boeing
19.	**Spacecraft Launch Site Test Plan** To provide all agencies with a detailed understanding of the launch site activities and operations planned for a particular mission, the spacecraft contractor is required to prepare a launch site test plan. The plan is intended to describe all aspects of the program while at the launch site. A suggested format is shown in Table 8-5.	Customer
20.	**Spacecraft Launch Site Procedures** Operating procedures must be prepared for all operations that are accomplished at the launch site. For operations that are hazardous (either to equipment or to personnel), special instructions must be followed in preparing the procedures. Refer to Section 9.	Customer
21.	**Spacecraft Integrated Test Procedure Inputs** On each mission, Boeing prepares launch site procedures for various operations that involve the spacecraft after it is mated with the Delta second stage. Included are requirements for operations such as spacecraft weighing, spacecraft installation to the third stage and encapsulation into the fairing, transportation to the launch complex, hoisting into the mobile service tower (MST) enclosure, spacecraft/third stage mating to the launch vehicle, flight program verification test, and launch countdown. Boeing requires inputs to these operations in the form of handling constraints, environmental constraints, personnel requirements, and equipment requirements. Of particular interest are spacecraft tasks/requirements during the final week before launch. (Refer to Section 6 or Section 7 for schedule constraints.)	Customer
22.	**Spacecraft Mass Properties Statement** The data from the spacecraft mass properties report represent the best current estimate of final spacecraft mass properties. The data should include any changes in mass properties while the spacecraft is attached to the Delta launch vehicle. Values quoted should include nominal and 3-σ uncertainties for mass, centers of gravity, moments of inertia, products of inertia, and principal axis misalignment.	Customer
23.	**RF Compatibility Analysis** A radio frequency interference (RFI) analysis is performed to verify that spacecraft RF sources are compatible with the launch vehicle telemetry and tracking beacon frequencies. Spacecraft frequencies defined in the mission specification are analyzed using a frequency-compatibility software program. The program provides a list of all intermodulation products that are then checked for image frequencies and intermodulation product interference.	Boeing

Table 8-3. Required Documents (Continued)

	Item	Responsibility
24.	**Spacecraft/Launch Vehicle Separation Memorandum** An analysis is performed to verify that there is adequate clearance and separation distance between the spacecraft and expended PAF/second stage. This analysis verifies adequate clearance between the spacecraft and second stage during separation and second-stage post-separation maneuvers.	Boeing (input required from Customer)
25.	**Launch Operations Plan (LOP)** This plan is developed to define top-level requirements that flow down into detailed range requirements. The plan contains the launch operations configuration that identifies data and communication connectivity with all required support facilities. The plan also identifies organizational roles and responsibilities, the mission control team and its roles and responsibilities, mission rules supporting conduct of the launch operation, and go/no-go criteria.	Boeing
26.	**Vehicle Information Memorandum (VIM)** Boeing is required to provide a vehicle information memorandum to the U.S. Space Command 15 calendar days prior to launch. The spacecraft agency will provide to Boeing the appropriate spacecraft on-orbit data required for this VIM. Data required are spacecraft on-orbit descriptions, descriptions of pieces and debris separated from the spacecraft, the orbital parameters for each piece of debris, payload spin rates, and orbital parameter information for each different orbit through final orbit. Boeing will incorporate these data into the overall VIM and transmit it to the appropriate U.S. government agency.	Boeing (input required from Customer)
27.	**Postlaunch Orbit Confirmation Data** To reconstruct Delta performance, orbit data at burnout (stage II or III) are required from the spacecraft contractor. The spacecraft contractor should provide orbit conditions at the burnout epoch based on spacecraft tracking prior to any orbit-correction maneuvers. A complete set of orbital elements and associated estimates of 3-σ accuracy is required (see Table 8-6).	Customer
28.	**Spacecraft-to-Launch Control Center (LCC) Wiring Diagram** For inclusion in the Mission Specification, Boeing will provide a spacecraft-to-LCC wiring diagram based on the spacecraft requirements. It will define the hardware interface from the spacecraft to the LCC for control and monitoring of spacecraft functions after spacecraft installation in the launch vehicle.	Boeing
29.	**Launch Site Integrated Procedures** Boeing prepares procedures, called launch preparation documents (LPDs), that are used to authorize work on the flight hardware and related ground equipment. Most are applicable to the booster and second-stage operations, but a few are used to control and support stand-alone spacecraft and integrated activities at the payload processing facility and on the launch pad after encapsulated payload mate. These documents are prepared by Boeing based on Boeing requirements; the inputs provided by the spacecraft contractor are listed in Item 21 and are available for review by the customer. LPDs are usually released a few weeks prior to use.	Boeing
30.	**Countdown Bar Charts** Daily schedules are prepared on hourly timelines for integrated activities at the launch pad following encapsulated spacecraft mate to the second stage. These schedules are prepared by the Boeing chief test conductor based on standard Boeing launch operations, mission-specified requirements, and inputs provided by the spacecraft contractor as described in the mission specification. (Typical schedules are shown in Sections 6 and 7) A draft is prepared several months prior to launch and released to the customer for review. The final is normally released several weeks prior to encapsulated spacecraft mate at the pad.	Boeing

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Table 8-6. Data Required for Orbit Parameter Statement

1. Epoch: Spacecraft Separation (prior to propulsive maneuvers)

2. Position and velocity components $(X, Y, Z, \dot{X}, \dot{Y}, \dot{Z})$ in equatorial inertial Cartesian coordinates.* Specify mean-of-date or true-of-date, etc.

3. Keplerian elements* at the above epoch:
   Semimajor axis, a
   Eccentricity, e
   Inclination, I
   Argument of perigee, ω
   Mean anomaly, M
   Right ascension of ascending node, Ω

4. Polar elements* at the above epoch:
   Inertial velocity, V
   Inertial flight path angle, $\gamma 1$
   Inertial flight path angle, $\gamma 2$
   Radius, R
   Geocentric latitude, ρ
   Longitude, μ

5. Estimated accuracies of elements and a discussion of quality of tracking data and difficulties such as reorientation maneuvers within 6 hr of separation, etc.

6. Constants used:
   Gravitational constant, μ
   Equatorial radius, R_E
   J_2 or Earth model assumed

7. Estimate of spacecraft attitude and coning angle at separation (if available).

*Note: At least one set of orbit elements in Items 2, 3, or 4 is required.

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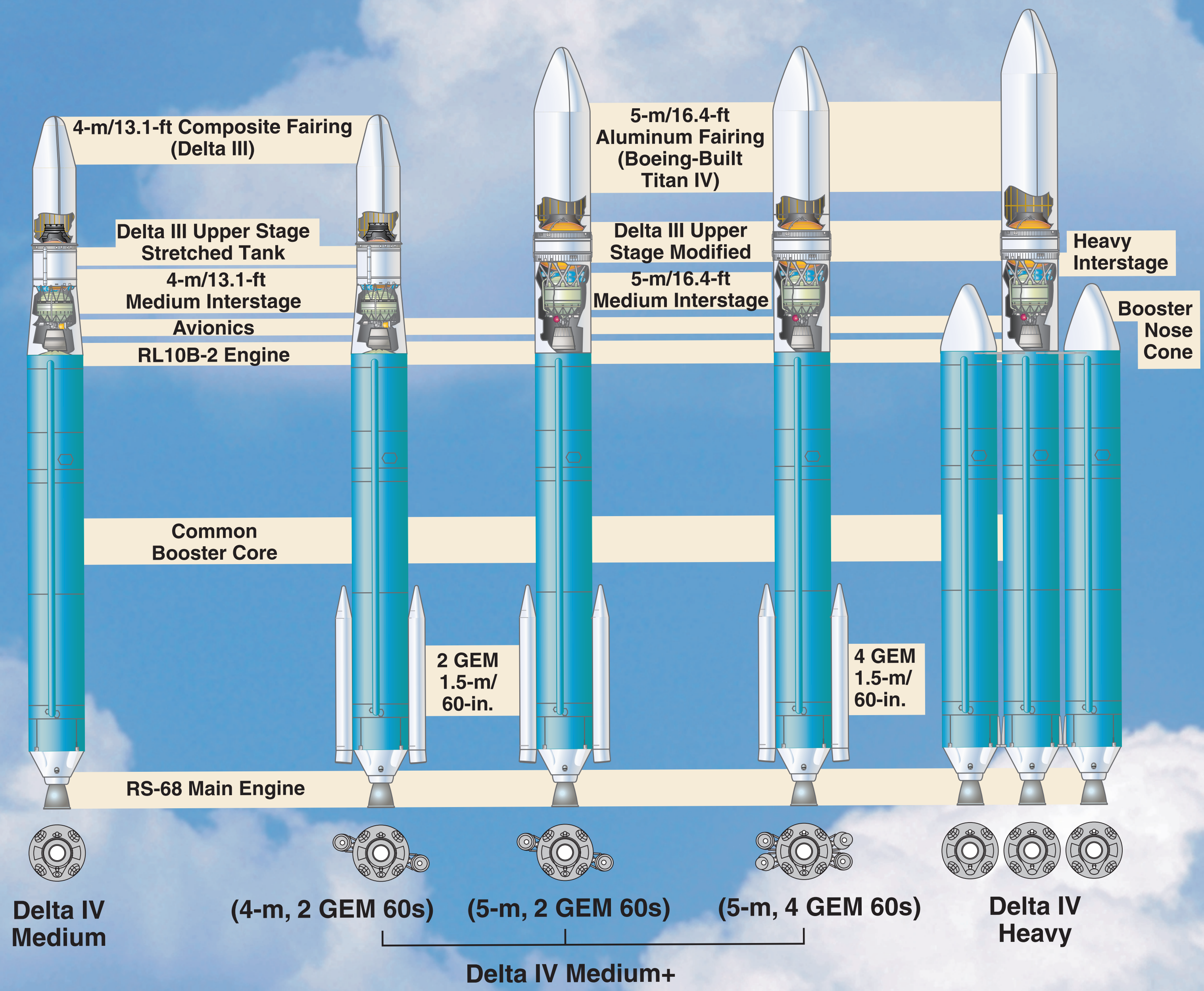
The Delta IV Family of Launch Vehicles



THE BOEING COMPANY
SPACE AND COMMUNICATIONS GROUP
5301 Bolsa Avenue
Huntington Beach, CA 92647-2099