

747ER 747

INTRODUCING THE AND



ER FREIGHTER



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TECHNOLOGY/PRODUCT DEVELOPMENT

The Longer Range 747-400 airplanes — the 747-400 Extended Range and 747-400 Extended Range Freighter — are the newest members of the 747 family. Through structural and system enhancements, these airplanes offer significant improvements in range and payload and provide greater reliability, maintainability, and flexibility.

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he 747-400 Extended Range and 747-400 Extended Range

Freighter are the newest members of the 747 family. The same size as today's 747-400 airplanes, the Longer Range 747-400s provide additional range or greater payload, allowing airlines and cargo carriers to fly longer routes or carry more cargo and passengers on existing routes.

The Longer Range 747-400 program was officially launched in November 2000 with an order from Qantas Airways for six passenger airplanes. Formal design of the 747-400ER began that same month. The first 747-400ER rollout was in June 2002, and Qantas took first delivery in October 2002.

The 747-400ER Freighter was launched in April 2001, with a five-airplane order from International Lease Finance Corporation. The first 747-400ER Freighter rollout was in September 2002, with the first delivery in October 2002 to Air France.

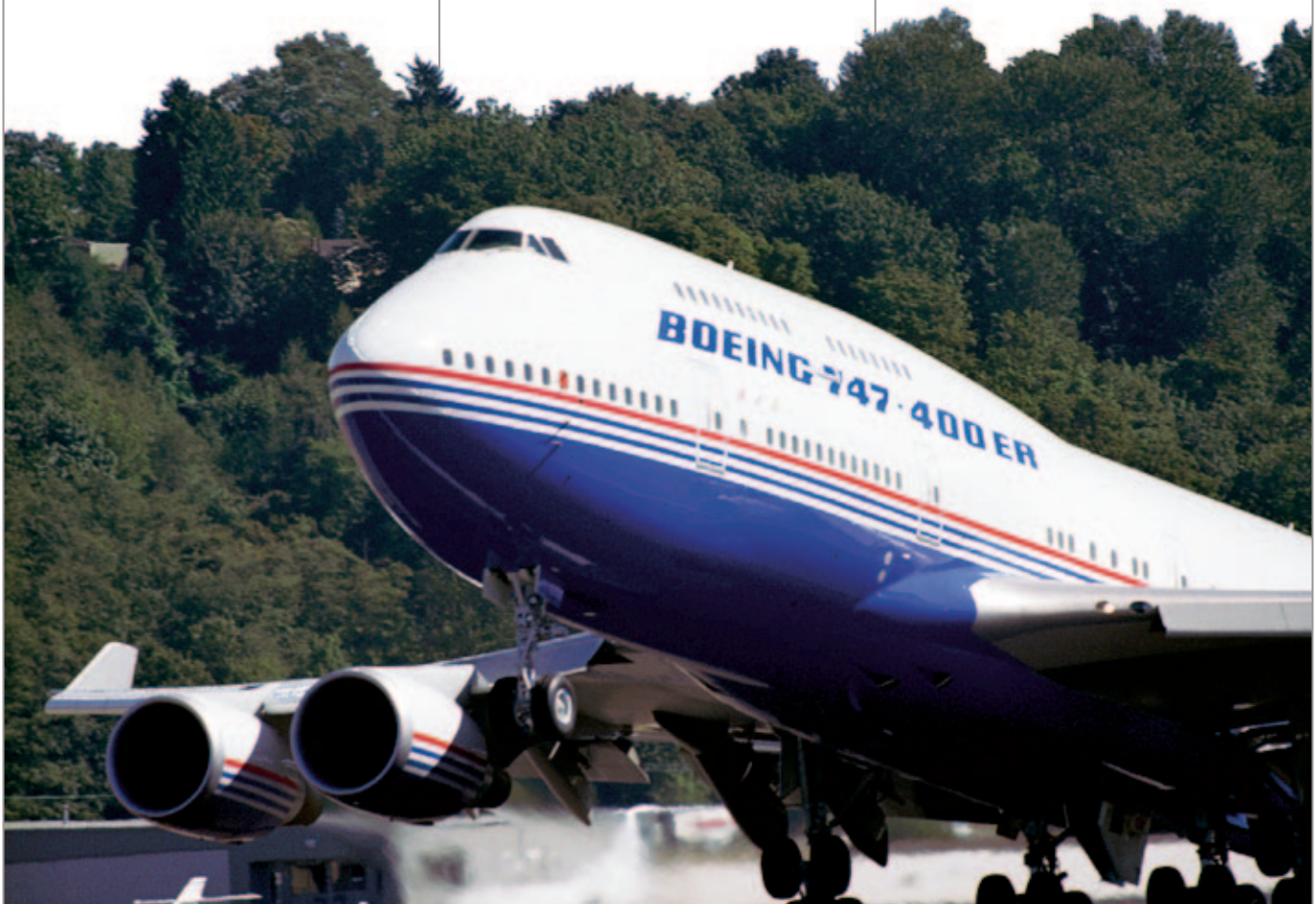
The 747-400ER and 747-400ER Freighter can be configured with General Electric CF6-80C2B5F, Pratt & Whitney 4062, or Rolls-Royce RB211-524H2-T engines. (The General Electric and Pratt & Whitney engines are offered on the standard 747-400 as optional, higher thrust engines.)

With the same shape as standard 747-400s, Longer Range 747-400s are able to use the same airport gates and can operate on the same runways and taxiways. The derivatives use the same pool of

spare parts as standard 747-400s; new parts were made to be one-way interchangeable with existing parts. The new airplanes also have a common type rating with the 747-400 and 747-400 Freighter, which minimizes flight crew training requirements and disruptions to flight operations.

The most significant differences between the standard 747-400 and the newest members of the 747 family are

1. Systems and structural revisions to support increased maximum takeoff weight.
2. Flight deck enhancements.
3. New auxiliary fuel system on the 747-400ER.
4. New interior on 747-400ER.





1

SYSTEMS AND STRUCTURAL REVISIONS TO SUPPORT INCREASED MAXIMUM TAKEOFF WEIGHT

The 747-400ER and 747-400ER Freighter both have a maximum takeoff weight of 910,000 lb (412,770 kg), which is 35,000 lb (15,785 kg) greater than that of the standard 747-400.

747-400ER. With a greater maximum takeoff weight than the standard 747-400, the 747-400ER can fly 7,670 nmi—approximately 410 nmi farther—or carry an extra 15,000 lb (6,803 kg) of payload, either as extra cargo or passengers (fig. 1).

747-400ER Freighter. The standard 747-400 Freighter can carry 248,000 lb (103,419 kg) of cargo approximately 4,450 nmi. With the 747-400ER Freighter, operators can fly an additional 525 nmi or carry an additional 22,000 lb (9,979 kg) of payload. The improvements to the 747-400ER Freighter provide additional operational flexibility (fig. 2).

Systems and structural changes were made to support the increase in takeoff weight.

- In areas where loads increased, the body and empennage were strengthened by increasing the thickness of the skins, stringers, frames, and bulkheads.

- The wing box skins were thickened, and the leading edge and trailing edge flaps and flap drive systems were strengthened.
- The landing gear and supporting structure were redesigned and larger, 50-in radial tires and wheels were installed.
- To accommodate those tires and to provide sufficient room to retract the wheels, the shape of the landing gear doors was modified.
- The systems located in the wheel wells were rerouted to protect against larger burst tire volumes.
- The Halon fire suppression system bottles were enlarged and relocated along the side of the aft cargo compartment.

2

FLIGHT DECK ENHANCEMENTS

The 747-400ER and 747-400ER Freighter flight deck was enhanced to incorporate systems changes and accommodate new operating limits. Most notably, software for the flight management computer, central maintenance computer, and weight and balance system was upgraded to include weight and performance data for the new derivatives.

Liquid crystal displays.

The six cathode ray tube (CRT) displays on the standard 747-400 flight deck have been replaced with liquid crystal displays (LCD) identical to those on the 767-400. Compared with CRT displays, LCDs weigh less, generate less heat, and have a longer mean time between failures. LCDs are able to display more information than CRT displays and are required on the 747-400ER to present the additional synoptics for the auxiliary fuel tank. The LCDs are line replaceable and can be intermixed with the 747-400 CRT displays, thereby reducing the cost of spares.

Integrated standby flight display.

Today's 747-400 flight decks include three standby displays—an attitude display, an airspeed display, and an altimeter. On the 747-400ER and 747-400ER Freighter, those three displays are combined into one LCD, the integrated standby flight display (ISFD). (The ISFD currently is an option on 747-400s but is expected to become standard late in 2003.) The ISFD has the same look as the primary flight display, which is the primary situational display. This similarity makes it easier for the crew to transition to the ISFD in the unlikely event that all main flight displays malfunction. The ISFD also weighs less and has a significantly longer life than its mechanical predecessors.

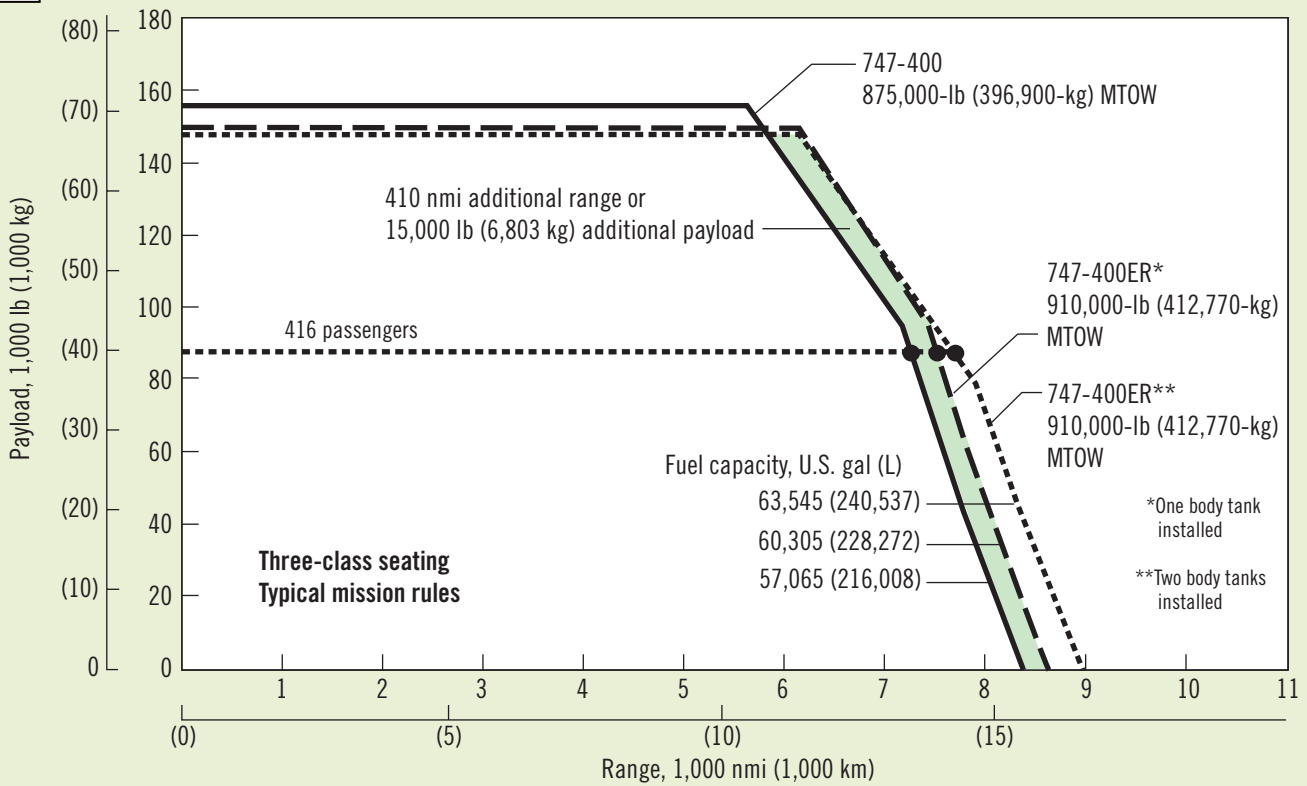
Reduced flight deck noise.

On the 747-400ER and 747-400ER Freighter, sound-damping insulation blankets in the overhead area of the flight deck reduce ambient noise. (All subsequent 747s will contain the blankets.) During flight tests, the blankets reduced overhead noise levels by more than 2 dBA. An optional treatment for flight deck windows two and three reduces ambient noise by an additional 1.5 dBA. When these two features are combined, the flight deck noise of the 747-400ER and 747-400ER Freighter is comparable to that of the quietest widebody jets now in production or planned for the future.

1

747-400ER INCREASES PAYLOAD AND RANGE

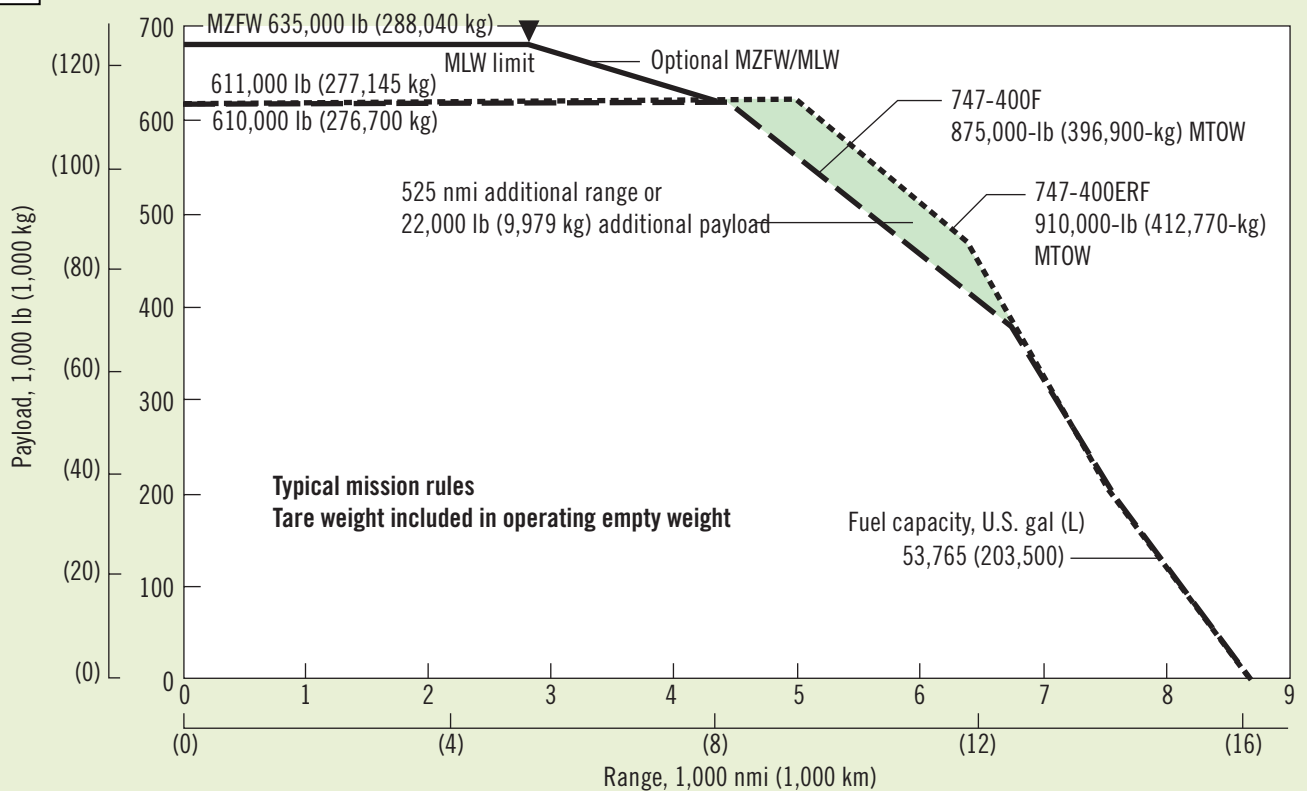
FIGURE



2

747-400ER FREIGHTER INCREASES PAYLOAD AND RANGE

FIGURE



3

NEW AUXILIARY FUEL SYSTEM ON THE 747-400ER

One of the most significant differences between the standard 747-400 and the 747-400ER is the auxiliary fuel system, which is available with one fuel cell or two. (The auxiliary fuel system is not used on the 747-400ER Freighter.) The 747-400ER is configured with a single fuel cell, which accommodates an additional 3,210 gal (12,151 L) of fuel when compared with the 747-400. Structural and systems provisions are provided for a second fuel cell, which can be ordered as an option or installed later. The one- and two-cell installations look like and are managed as a single auxiliary tank (fig. 3).

The auxiliary tank is located in the lower lobe, immediately in front of the center wing tank, where cargo containers usually are carried. To accommodate the auxiliary fuel tank, the potable water system was moved to the aft end of the aft cargo compartment, and the size of the forward cargo compartment was reduced. Whenever possible, common fuel systems components were used.

The fuel cell suspension system and attaching structure were designed to allow for quick installation. The cells are installed or removed with a special tool rolled in and out on the cargo system rollers. Fuel cells and components are readily accessible—without removing the cells from the airplane—through line replaceable units mounted on the front panel and walkways to the right of and between the cells.

The fuel cells are constructed from double-walled aluminum honeycomb panels that are reinforced and stiffened with a metallic secondary structure. Fuel cells are protected from shifting cargo by a barrier attached to the front side of the forward-most auxiliary fuel cell. The fuel tank is suspended 5 in above the cargo floor and 4 in below the cargo ceiling and is isolated from normal airplane deflections by a six-point suspension system anchored with titanium fittings.

3

SINGLE AUXILIARY TANK FUEL CELL

FIGURE



The body structure in this zone was completely redesigned to protect the auxiliary tank from damage in the event of an emergency such as a wheels-up landing. Existing sheet-metal frames were replaced with single-piece machined frames. To ensure adequate strength for decompression, a higher strength material is used for the chords of the main deck floor beams. To minimize the possibility of fuel cell damage in the event of a burst engine rotor, a titanium shield is installed on the forward body and wing ribs.

The auxiliary tank is segregated from the cargo compartment by a structural cargo barrier and cargo liners. The tank and its immediate environment were designed to keep the tank within structural temperature and fuel temperature limits in the rare event of a cargo fire.

During flight, fuel is used first from the center fuel tank. As the flight progresses, fuel is transferred from the auxiliary tank to the center tank using air pressure provided by one of two independent sources. The primary source is cabin air pressure. The secondary source, which is used at low altitudes or when the airplane is on the ground (during fuel jettison or on-the-ground defueling), is an electrically powered

blower. A switch for the auxiliary tank transfer valves has been added to the fuel management area of the pilot's overhead panel, which allows the crew to operate the fuel tank manually. Because the new tank is fully integrated into and operates seamlessly with the existing fuel system, there is no increase to the flight crew's workload.

Although auxiliary fuel systems that use air pressure to transfer fuel have been used before on Boeing and other airplanes, this is the first such system designed by Boeing Commercial Airplanes.

4

NEW INTERIOR ON THE 747-400ER

From the passenger perspective, perhaps the most notable change is the updated interior of the 747-400ER. The award-winning Boeing signature interior, first developed for the 777, is distinguished by curved architecture and a brighter color scheme than on the standard 747-400. The new interior has a blended ceiling and bin line and pivot bins that provide approximately 30 percent more space for roll-aboard luggage than the standard 747-400. The new bins and bin line offer more passenger headroom, afford better

access to luggage, and hold stowed luggage in place more securely. The upper deck of the 747-400ER also has twice the stowage capacity of standard 747-400s. (Boeing is considering whether to offer this new interior on future 747-400s and as part of a retrofit for standard 747-400s already in service.)

During the design process, each interior system was evaluated for reliability and maintenance costs. System enhancements include the following.

An electrically activated passenger oxygen system replaces the passenger oxygen system on the 747-400. The new system, which uses many components developed for the 777, is easier to rig and maintain than the system on the 747-400.

A two-pump potable water system replaces the pressurized potable water system on the standard 747-400. On the 747-400, the system is located in the forward cargo hold. Because this space is occupied by the auxiliary fuel tank on the 747-400ER, a new potable water tank was designed and located in the bulk cargo area. This tank is fitted with a two-pump water delivery system, similar to that on the 777. The two-pump system increases dispatch reliability; if one pump fails, the system switches automatically to the functional

pump. After each flight, the system toggles from one pump to the other. This distributes operating hours between the pumps and provides a backup if one pump fails on the ground or during flight.

A quick-charge emergency lighting battery replaces the trickle-charge battery. The new battery weighs less, is slightly less expensive, and has a longer life expectancy, which makes it more economical. More significant, the quick-charge battery can be recharged in approximately 1 hr, compared with 8 to 10 hr for the trickle-charge battery. This difference allows operators to return airplanes to service much more quickly after using, maintaining, or testing emergency lighting.

Light-emitting-diode-illuminated sign packs replace incandescent bulb information sign packs. The new signs are brighter, are similarly priced, and have a significantly longer life expectancy, which translates into less maintenance and lower maintenance costs.

New backbone wiring for the in-flight entertainment interface, which will accommodate any interior layout. Because each airline has a different interior layout with different in-flight entertainment (IFE) equipment, the wiring for each IFE installation also

differs significantly, making it cumbersome to modify the interior layout after delivery. All 747-400ERs equipped with an IFE system include the new IFE interface backbone wiring, making it easier, quicker, and more efficient to change the interior layout. (All subsequent 747-400 passenger airplanes will include the new wiring.)

SUMMARY

The 747-400 ER and 747-400ER Freighter—the newest derivatives of the 747 family—are unique in their classes. Features include a maximum takeoff weight of 910,000 lb, which makes it possible to fly farther or carry more payload, and an enhanced flight deck that offers new LCDs, a new ISFD, and additional insulation to reduce noise. The 747-400ER also has a new auxiliary fuel system, available with one fuel cell or two; a newly designed interior; and enhanced interior systems.



About the Author

Kurt Kraft

has held engineering and leadership positions on a variety of Boeing propulsion and airplane programs since 1979, including 747 Airplane Level Integration Team (ALIT) leader, 767-400 Propulsion Platform team leader, and Propulsion chief engineer for the 737/757 Programs.

TECHNICAL CHARACTERISTICS OF THE 747-400 AND 747-400ER

	747-400	747-400ER
Seating (typical three-class configuration)	416	416
Maximum takeoff weight	875,000 lb (396,900 kg)	910,000 lb (412,770 kg)
Maximum landing weight	652,000 lb (295,740 kg)	652,000 lb (295,740 kg)
Range:		
Statute miles	8,360 miles	8,830 miles
	7,260 nmi	7,670 nmi
	13,445 km	14,205 km
City pairs	Los Angeles–Hong Kong Los Angeles–Sydney Singapore–London	New York–Hong Kong Los Angeles–Melbourne Rio de Janeiro–Perth
Cruise speed at 35,000 ft	Mach 0.855 567 mi/h (912 km/h)	Mach 0.855 567 mi/h (912 km/h)
Engines:		
maximum thrust	Pratt & Whitney 4062 63,300 lb (28,710 kg)	Pratt & Whitney 4062 63,300 lb (28,710 kg)
	Rolls-Royce RB211-524H2-T 59,500 lb (26,990 kg)	Rolls-Royce RB211-524H2-T 59,500 lb (26,990 kg)
	General Electric CF6-80C2B5F 62,100 lb (28,165 kg)	General Electric CF6-80C2B5F 62,100 lb (28,165 kg)
Maximum fuel capacity	57,285 U.S. gal (216,840 L)	63,705 U.S. gal (241,140 L)*
Length	231 ft 10 in (70.6 m)	231 ft 10 in (70.6 m)
Wingspan	211 ft 5 in (64.4 m)	211 ft 5 in (64.4 m)
Tail height	63 ft 8 in (19.4 m)	63 ft 8 in (19.4 m)
Cargo volume	6,025 ft ³ (170.5 m ³) or 5,332 ft ³ (151 m ³)**	5,599 ft ³ (158.6 m ³) or 4,837 ft ³ (137 m ³ ***)
Exterior diameter	21 ft 3.5 in (6.5 m)	21 ft 3.5 in (6.5 m)
Interior cross-section width	20 ft 1.5 in (6.1 m)	20 ft 1.5 in (6.1 m)

*With two auxiliary body fuel tanks in the forward lower cargo hold. The fuel capacity with one body tank is 60,495 U.S. gal (228,990 L).

**6,025 ft³ (170.5 m³) = 30 LD-1 containers + bulk; 5,332 ft³ (151 m³) = five pallets, 14 LD-1 containers + bulk (one pallet = 96 in x 125 in, 244 cm x 318 cm).

***5,599 ft³ (158.6 m³) = 28 LD-1 containers + bulk; 4,837 ft³ (137 m³) = four pallets, 14 LD-1 containers + bulk (one pallet = 96 in x 125 in, 244 cm x 318 cm).
These volumes are reduced relative to the 747-400 because of the addition of one body fuel tank, basic on the 747-400ER, in the forward lower cargo hold.