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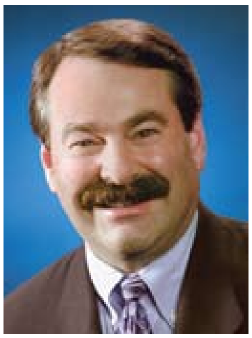
Moving Forward: Jeppesen Expands Products and Markets



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Although our roots are firmly planted in aviation, we also now service new markets, such as marine and rail. Jeppesen customers include some of the largest shipping lines in the world, and some of the foremost passenger and freight rail operators.

To reflect these changes, and our forward-looking view, we are building on our iconic brand by coupling a new symbol with our well-known typeface. The look is that of Jeppesen today — contemporary and innovative — but with the character that has made us unique for nearly 75 years. The symbol itself is abstract, evoking the businesses of our customers and the integration of products, services, and data.

This logo change reinforces our message to look again at Jeppesen to see the many things we offer and can do to help you operate your airline at peak efficiency while minimizing your effect on the environment.

Trust is the word that customers most often associate with Jeppesen — trust in the accuracy of our information; trust in the quality of our products and services; and trust in our integrity to stand behind our work. At the same time, customers are never shy about telling us what they want — more integration, greater levels of efficiency, and, above all, more responsiveness. You want a true partner, one who understands you and the challenges you face every day and who is ready and able to solve the most pressing demands of today and tomorrow.

Jeppesen has been and will continue to be that partner. Our hallmark has been tailoring solutions to meet unique customer needs. We integrate information from multiple sources to deliver the right information the way you need it, when you need it most.

We are serious about the changes we have undertaken and serious about helping you fulfill your business objectives. Please feel free to contact us at captain@jeppesen.com.

MARK VAN TINE
President and Chief Executive Officer
Jeppesen

Jeppesen's logo, seen here in an advertisement, couples a new symbol with a well-known typeface.


BOEING

ALTHOUGH MOST RAMP EQUIPMENT FOR THE 767 AND 777 WILL SERVICE THE 787-8, OPERATORS SHOULD BE AWARE OF EXCEPTIONS.

Preparing Ramp Operations for the 787-8

By Jo Fossen
Maintenance Engineer,
Maintenance and Ground Operations Systems

Planning for the introduction of a new airplane requires the participation and cooperation of personnel in virtually all areas of an airline. Though Boeing strives for commonalities with existing airplanes, each new model has its own special requirements for equipment and tools needed for ramp operations. The Boeing 787 Dreamliner is no exception. Management and maintenance personnel can ensure a smooth transition to this new airplane by understanding what it has in common with existing airplanes in the airline's fleet, as well as what is unique, and plan accordingly.

787-8 COMPARED TO OTHER BOEING AIRPLANES

Figure 1

The Boeing 787-8 is similar in size to the 767-300ER. However, the 787-8 has a longer wing span.

AIRPLANE	777-300ER	787-8	767-300ER
			
LENGTH	242 ft 4 in (73.8 m)	186 ft 1 in (56.7 m)	177 ft 9 in (54.2 m)
WING SPAN	212 ft 7 in (64.8 m)	197 ft 3 in (60.1 m)	156 ft 1 in (47.6 m)
TAIL HEIGHT	61 ft 10 in (18.8 m)	55 ft 6 in (16.9 m)	52 ft 7 in (16.0 m)

Preparing for new equipment ahead of time will help guarantee a smooth transition to the 787. This article provides a preliminary assessment of general 787-8 ramp equipment requirements.

787-8 RAMP SERVICING

To prepare to service the 787 at the ramp, operators need to have basic information about the airplane's dimensions (see fig. 1), servicing locations (see fig. 2), and typical servicing arrangement (see fig. 3).

Boeing estimates that a 787-8 dual-class airplane with 275 passengers deplaning and boarding through a single door and taking on a full load of fuel can be turned around at the gate in approximately 44 minutes (see fig. 4).

TOWING REQUIREMENTS

The 787-8 shares a common towbar nose tow fitting with the 767 and 777. As with Boeing airplanes, the 787-8 towbar has a unique shear pin. Boeing towbar specification drawing K09001 provides data on towing loads, which can be accessed through the Web portal MyBoeingFleet.com.

The 787-8 can use the same tow tractor as the 777. With a maximum taxi weight of 486,000 pounds (220,446 kilograms), the tow tractor should have a design weight of 75,600 pounds (34,291 kilograms) and a drawbar pull of 34,020 pounds (15,431 kilograms). The coefficient of friction between the tractor tire and pavement used is 0.45. The 787-8 is also compatible with towbarless vehicles. As with the 777, the amount that a towbarless vehicle is used for dispatching a 787-8 for flight is limited to 25 percent. The Service Letter 787-SL-09-001 contains details on towbarless towing and has been updated to include the 787.

ELECTRICAL POWER

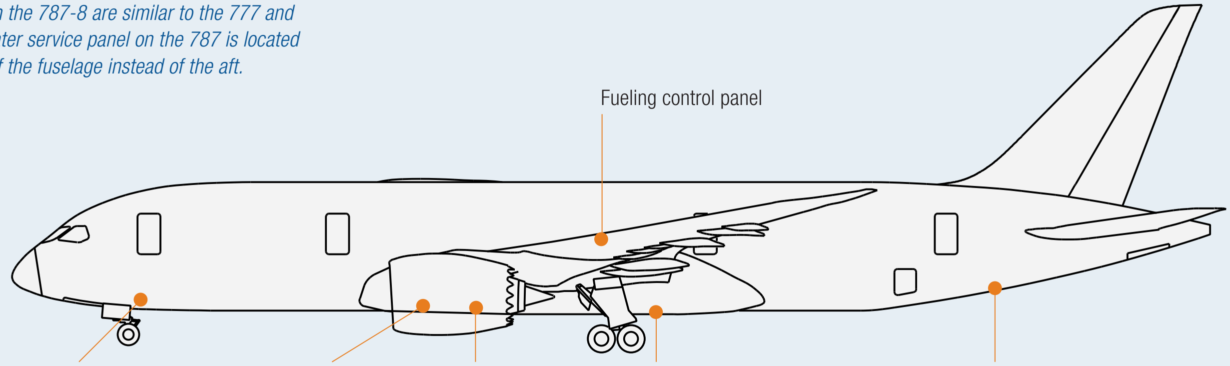
The 787-8 airplane utilizes two forward ground power receptacles and one mid-aft ground power receptacle. Receptacle ground heights are minimum 81 inches (206 centimeters) and maximum 108 inches (274 centimeters). Each receptacle is rated at 90 kilovolt amperes (KVA), the same as other Boeing twin-aisle production airplanes.

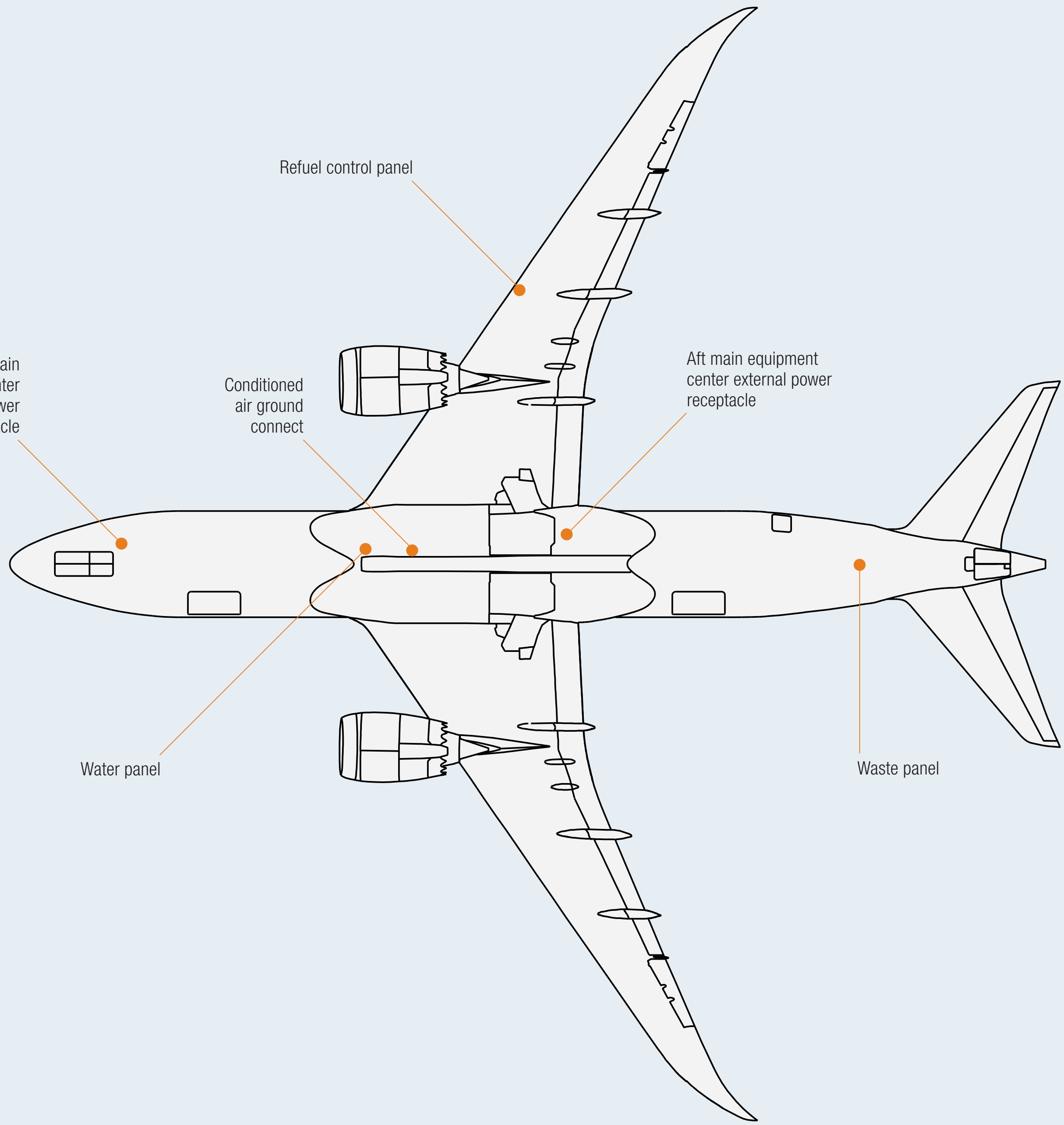
Similar to existing airplanes, the 787 utilizes power from the auxiliary power unit (APU) for engine start. The 787 is different in that it uses electrical power for engine start rather than the pneumatic power used on existing airplanes.

787-8 AIRPLANE SERVICING LOCATIONS

Figure 2

Servicing locations on the 787-8 are similar to the 777 and 767. However, the water service panel on the 787 is located on the forward part of the fuselage instead of the aft.

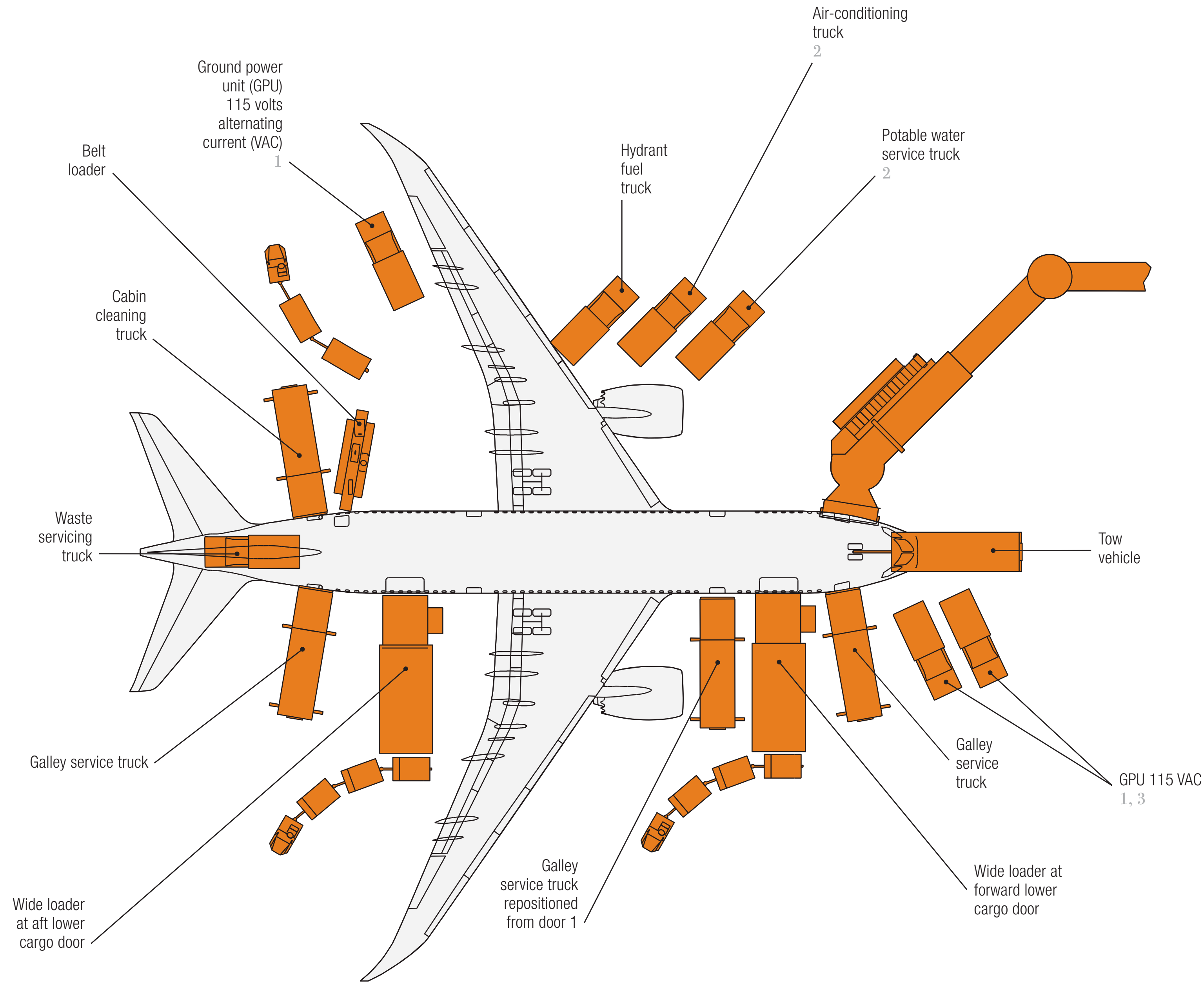




787-8 AIRPLANE SERVICING ARRANGEMENT

Figure 3

This figure shows a typical ground servicing arrangement for a 787-8 airplane. Note that three ground power sources are used when the APU is inoperative.



1 Not necessary for APU-assisted engine start.

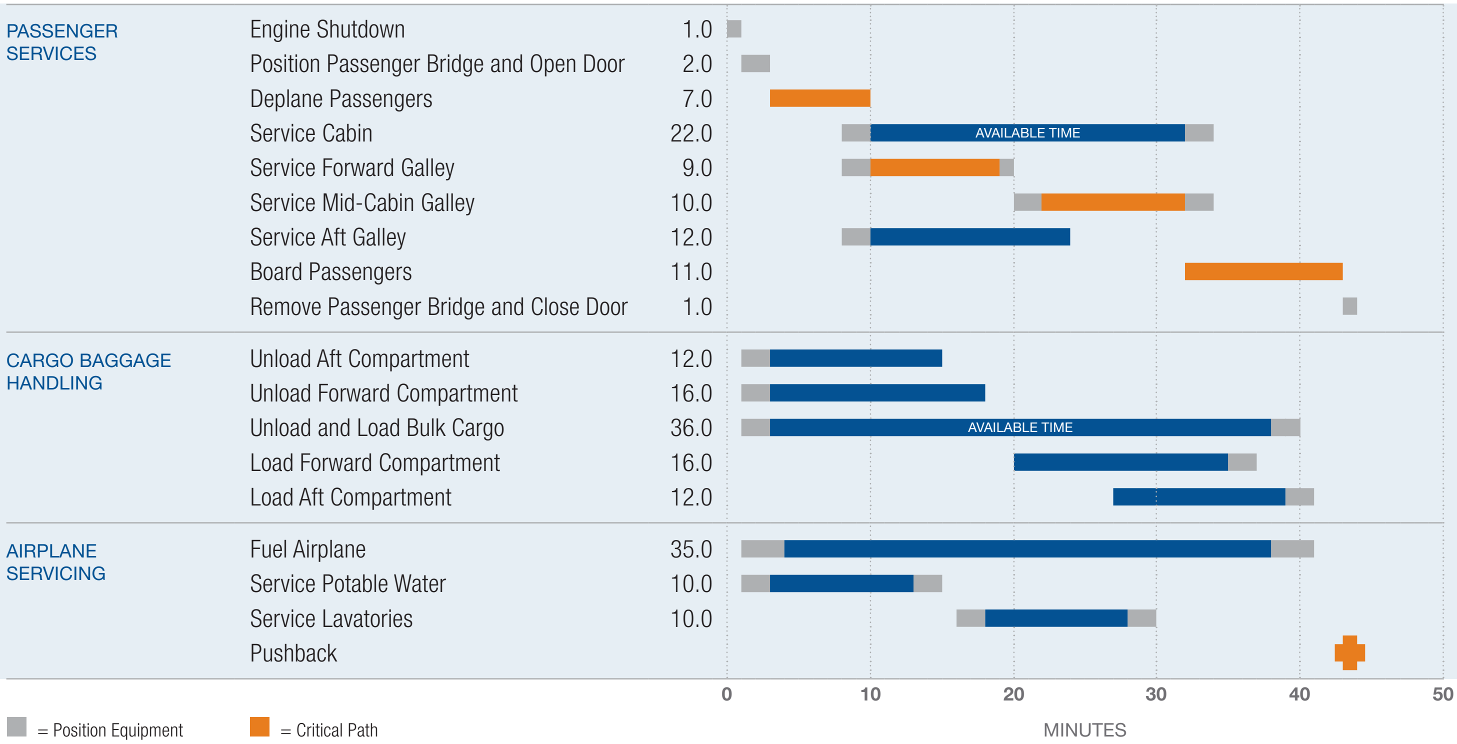
2 Potable water, ground power, and/or air-conditioning may be supplied from the passenger bridge if so equipped.

3 Airplane electrical receptacles are located on the left side of the airplane. (The GPUs are shown on the right side mainly due to congestion around passenger bridge at the left forward door.)

787-8 SERVICING ESTIMATE

Figure 4

Boeing estimates that a 787-8 airplane with 275 passengers can be turned around at the gate in less than 45 minutes.



PARAMETERS

- *100% passenger and cargo exchange*
- *275 passengers, 2 classes, 1 door*
- *2 galley service trucks*
- *1 lavatory service truck*
- *Passenger deplane rate is 40 per minute*
- *Passenger boarding rate is 25 per minute*
- *Unload and load bulk cargo is available time*
- *Cabin service is available time*
- *12 containers aft*
- *16 containers forward*
- *29,798 U.S. gallons fuel loaded, 3,730-U.S. gallon (14,120-liter) reserve 2 nozzle hydrant fueling at 50 psi*
- *Bulk cargo in bulk compartment at 75% utilization and 8.5 pounds per cubic foot*

If the APU is inoperative, an engine start can be performed using a minimum of two 90 KVA external ground power units (GPUs). Boeing recommends the use of three 90 KVA ground power sources to decrease engine start times and minimize ramp impact during ground operations. Same as the 777 and other twin-aisle airplanes, the ground power requirements must conform to the electrical power quality requirements specified in figure 5.

DOOR LOCATIONS AND DIMENSIONS

The 787-8 is equipped with eight passenger entry doors — four on each side of the airplane — two cargo doors on the right side, and one bulk cargo door on the left side (see fig. 6). Passenger stairs and bridges are common with 767 and 777 airplanes.

FUELING

The total fuel capacity for the 787-8 is 33,528 U.S. gallons (126,917 liters). A fueling control panel is installed in the left wing only. The left wing has a fueling panel with two receptacles, each rated for 500 U.S. gallons per minute (1,893 liters per minute) at 55 pounds per square inch (psi) gauge (379 kilopascal).

Any standard fuel truck (i.e., hydrant/tanker) with the appropriate length fuel line that can reach the 787-8 receptacles can be used. Fuel receptacle ground height for the 787-8 and other Boeing airplanes is shown in figure 7.

Assuming a 3,730-U.S. gallon (14,120-liter) reserve, the 787-8 can be refueled to capacity in 35 to 60 minutes, depending on the fuel pressure.

CARGO SYSTEM

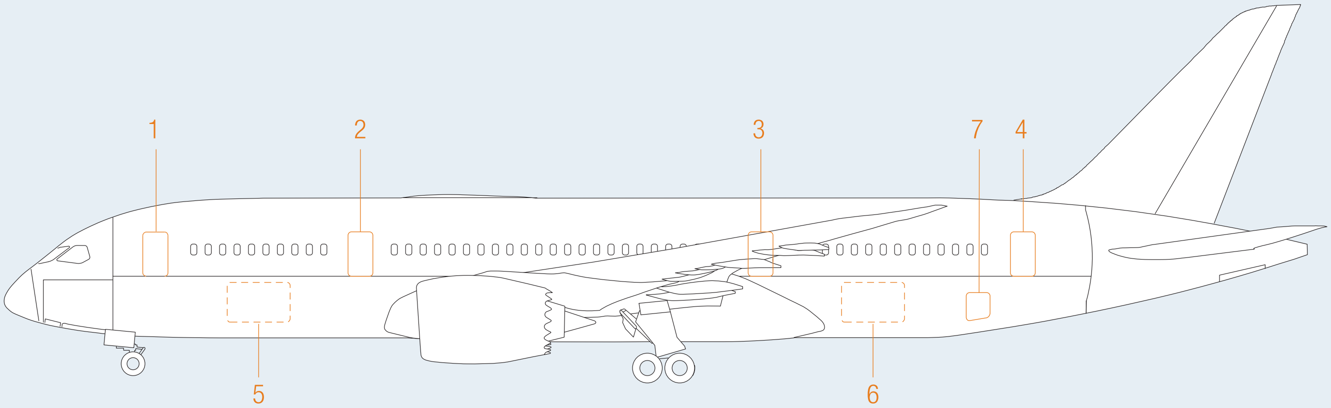
The 787-8 has forward- and aft-powered cargo compartments (see fig. 8), as well as a compartment for bulk cargo.

GROUND POWER REQUIREMENTS
Figure 5

	PARAMETER	787 GROUND POWER EQUIPMENT REQUIREMENTS (EXTERNAL POWER BUS PROTECTION)
POWER CONSUMPTION	Maximum power consumption (per receptacle)	90 kilovolt amperes (KVA) (continuous)
	Peak power consumption (per receptacle)	112.5 KVA, 0.75–1.0 pico-farad per receptacle (5 minutes)
VOLTAGE REQUIREMENTS	Normal voltage range	115/200 +/– 2 volts alternating current (VAC)
	Allowable voltage range	115 +/– 5 VAC L–N root mean square (RMS)
FREQUENCY REQUIREMENTS	Normal frequency	400 +/– 5 Hertz (Hz)
	Allowable frequency range	400 +18/–15 Hz
MAXIMUM DISTORTION FACTOR	Total harmonic content	3% of fundamental
	Individual harmonic content	2% of fundamental
	Crest factor	1.414 +/– 0.07
	Maximum voltage modulation factor	2.5 V peak to valley (0.5%)
EXTERNAL POWER BUS PROTECTION (ON AIRPLANE)	115 V bus, overvoltage	Above 182 VRMS (2.5 +/– .5 second [sec]) = "trip" 132 VRMS – 129 VRMS (2.5 +/– 0.25 sec) = "may trip"
	115 V bus, undervoltage	Below 103 VRMS (0.5 +/– 0.25 sec) = "trip" 103 VRMS – 106 VRMS (0.5 +/– 0.25 sec) = "may trip" * Undervoltage trip inhibited during fault conditions when over current is present
	Overfrequency	Above 430 Hz (1.0 +/– 0.2 sec) = "trip" 425 Hz – 430 Hz (1.0 +/– 0.2 sec) = "may trip"
	Underfrequency	Below 370 Hz (1.0 +/– 0.2 sec) = "trip" 370 Hz – 375 Hz (1.0 +/– 0.2 sec) = "may trip"

787-8 DOOR LOCATIONS AND DIMENSIONS
Figure 6

LOCATION	1	2	3	4	5	6	7
DOOR	Passenger entry door 1 (left side)	Passenger entry door 2 (left side)	Passenger entry door 3 (left side)	Passenger entry door 4 (left side)	Forward cargo door (right side)	Aft cargo door (right side)	Bulk cargo door (left side)
MAXIMUM GROUND HEIGHTS	185.5 in (471.2 cm)	185.2 in (470.4 cm)	188.4 in (478.5 cm)	194.2 in (493.3 cm)	108.2 in (274.8 cm)	114.4 in (290.4 cm)	118.9 in (302.0 cm)



FUEL RECEPTACLE GROUND HEIGHT
Figure 7

AIRPLANE	777-300ER	787-8	767-300ER
FUEL RECEPTACLE (MAXIMUM GROUND HEIGHT)	215 in (547 cm)	210 in (533 cm)	176 in (447 cm)

Standard lower lobe loaders can be used with pallets loaded with the 96-inch (244-centimeter) side through the door, similar to 777 airplanes. In order to properly align the last two containers on the loader, Boeing recommends the use of loaders with side-shift capability on the loader front platform (e.g., bridge).

Standard lower lobe loaders can be used with pallets loaded with the 96-inch (244-centimeter) side through the door, similar to 777 airplanes. In order to properly align the last two containers on the loader, Boeing recommends the use of loaders with side-shift capability on the loader front platform (e.g., bridge).

The bulk cargo compartment has a volume of 402 cubic feet (11.38 cubic meters). Standard belt loaders with the capability to reach the cargo door sill height (see fig. 9) can be used on 787-8 airplanes.

WASTE SYSTEM

The 787-8 uses a vacuum waste system similar to the 767 and 777. A single aft servicing panel with standard connections is used to service the system. Servicing heights are minimum 107 inches (272 centimeters) and maximum 119 inches (302 centimeters).

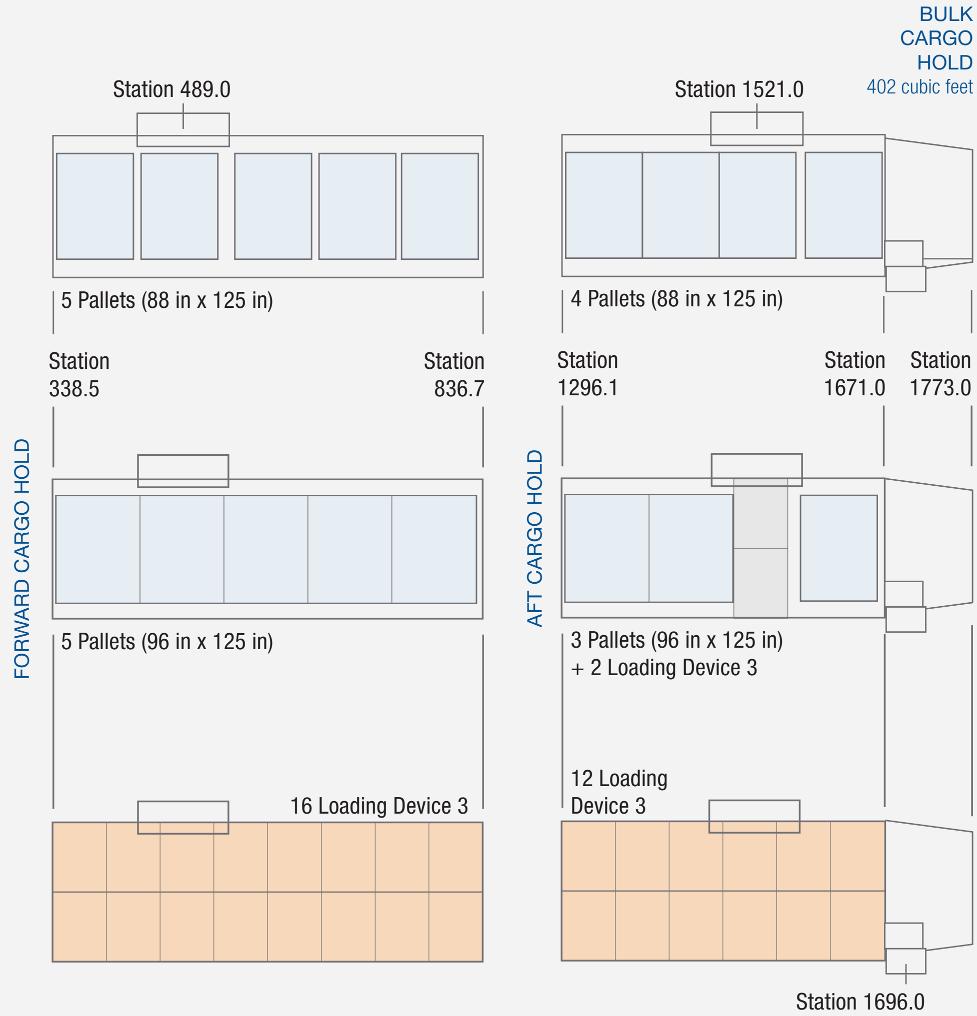
At 430 U.S. gallons (1,628 liters), the 787 has a greater waste tank capacity than any other Boeing airplane because the drain masts have been deleted from the 787. All gray water drains into the waste tanks.

As a result, the service truck needs to accommodate the 430 U.S. gallons (1,628 liters) of waste and 100 U.S. gallons (379 liters) of flush water used to rinse waste tanks. (Some 10 to 50 U.S. gallons [38 to 189 liters] of water is used to rinse each tank during servicing.) If the tanks are full, a 530-U.S. gallon (2,006-liter) service truck is recommended. A lavatory service truck common to the 767 and 777 may be used.

POTABLE WATER SYSTEM

Potable water on the 787-8 is stored in unpressurized tanks located behind the bulk cargo compartment. Two 135-U.S. gallon (511-liter) tanks provide a total capacity of 270 U.S. gallons (1,020 liters). An ultraviolet water treatment system is provided in the water tank fill line. Water treatment takes place during upload of water into the airplane. Electric pumps provide water pressure.

787-8 CARGO CONFIGURATIONS
Figure 8



The basic configuration has a single servicing panel located just forward of the wing.

Potable water servicing trucks should have a tank capacity of 270 U.S. gallons (1,020 liters) with a water pressure of 30 psi. Servicing heights are minimum 76 inches (193 centimeters) and maximum 77 inches (196 centimeters). Trucks common with the 767 and 777 may be used.

AIR-CONDITIONING

To provide air-conditioning to the airplane from an external source, a 90-ton air-conditioning/heater unit is recommended. The 787-8 has one standard air-conditioning servicing connection with a minimum ground height of 71 inches (180 centimeters) and maximum ground height of 79 inches (201 centimeters). Trucks used to provide conditioned air to the 787-8 are common with the 767 and 777 airplanes.

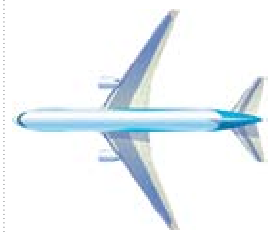
SUMMARY

The majority of current ramp equipment for the 767 and 777 will service the 787-8. However, operators should be aware of these possible ground service equipment requirements:

- Additional GPUs may be needed for ground power and engine start.
- The 787-8 has a unique towbar shear pin.
- Newer cargo loaders with side-shift capability on the loader front platform (e.g., bridge) are recommended.
- Lavatory service truck capacity for 787 operations should be evaluated.

For more information, please contact Jo Fossen at jeonalyn.c.fossen@boeing.com.

Figure 9

AIRPLANE	777–300ER	787-8	767–300ER
			
RAMP EQUIPMENT			
MAXIMUM DESIGNED TAXI WEIGHT	777,000 lb (352,441 kg)	486,000 lb (220,446 kg)	413,000 lb (187,334 kg)
TOW TRACTOR	54,390 lb (24,671 kg) drawbar pull	34,020 lb (15,431 kg) drawbar pull	24,780 lb (11,240 kg) drawbar pull
TOWBAR*	■ Nose tow fitting common with 767 and 787 ■ Unique 777 shear pin diameter	■ Nose tow fitting common with 767 and 777 ■ Unique 787 shear pin diameter	■ Nose tow fitting common with 777 and 787 ■ Unique 767 shear pin diameter
ELECTRICAL POWER	Two 90 KVA sources (two external receptacles) ■ Maximum ground height: 118 in (300 cm)	Three 90 KVA sources (four external receptacles) ■ Maximum ground height: 108 in (274 cm)	One 90 KVA source ■ Maximum ground height: 97 in (246 cm)
LOWER LOBE CARGO LOADER WITH SIDE SHIFT CAPABILITY	Standard width loader (96 in + between guides) ■ Maximum door ground height: 141 in (358 cm)	Standard width loader (96 in + between guides) ■ Maximum door ground height: 114 in (290 cm)	Wide loader (125 in between guides) ■ Maximum door ground height: 101 in (257 cm)
BULK CARGO LOADER	Standard belt loader ■ Maximum door ground height: 148 in (376 cm)	Standard belt loader ■ Maximum door ground height: 114 in (290 cm)	Standard belt loader ■ Maximum door ground height: 102 in (259 cm)
CONTAINERS (BASIC)	Fwd lower lobe: 24 loading device 3, or 8 pallets (96 in x 125 in) Aft lower lobe: 20 loading device 3, or 6 pallets (96 in x 125 in)	Fwd lower lobe: 16 loading device 3, or 5 pallets (96 in x 125 in) Aft lower lobe: 12 loading device 3, or 4 pallets (96 in x 125 in)	Fwd lower lobe: 16 loading device 2, or 4 pallets (96 in x 125 in) Aft lower lobe: 14 loading device 2
FUEL TRUCK	Total airplane fuel capacity: 47,890 U.S. gal (181,283 l) ■ Maximum fuel receptacle height: 215 in (546 cm)	Total airplane fuel capacity: 33,528 U.S. gal (126,917 l) ■ Maximum fuel receptacle height: 210 in (533 cm)	Total airplane fuel capacity: 24,140 U.S. gal (91,380 l) ■ Maximum fuel receptacle height: 175 in (445 cm)
AIR-CONDITIONING TRUCK **	Two standard 8-in connector ■ Maximum ground height: 103 in (262 cm)	One standard 8-in connector ■ Maximum ground height: 79 in (201 cm)	One standard 8-in connector ■ Maximum ground height: 90 in (229 cm)
AIR START CART ***	Three standard 3.5-in diameter connectors ■ Maximum ground height: 102 in (259 cm)	N/A	Two standard 3.5-in diameter connectors ■ Maximum ground height: 84 in (213 cm)
POTABLE WATER TRUCK	One service panel ■ Total airplane capacity: 327 U.S. gal (1,238 l) ■ Maximum ground height: 129 in (328 cm)	One service panel ■ Total airplane capacity: 270 U.S. gal (1,022 l) ■ Maximum ground height: 77 in (196 cm)	Two service panels ■ Total airplane capacity: 149 U.S. gal (564 l) ■ Maximum ground height: 81 in (206 cm)
LAVATORY WASTE TRUCK	One aft service panel ■ Total waste tank capacity: 249 U.S. gal (943 l) ■ Maximum ground height: 132 in (335 cm)	One aft service panel ■ Total waste tank capacity: 430 U.S. gal (1,628 l) ■ Maximum ground height: 119 in (302 cm)	One aft service panel ■ Total waste tank capacity: 116 U.S. gal (439 l) ■ Maximum ground height: 114 in (290 cm)

* Towbar designs vary among manufacturers.

** The size of the air-conditioning truck is dependent upon outside temperature, humidity, and cabin conditions, (i.e., number of passengers, electrical load).

*** Air start requirements are dependent on ambient temperature and altitude. Please refer to the airplane's Maintenance Facility and Equipment Planning Document (777 [D626W001] and 767 [D6-48646]).

AIRLINES MUST WORK WITH THEIR FUEL SUPPLIERS TO ENSURE THAT LOCAL FUEL HANDLING PROCEDURES ARE BEING FOLLOWED.

Engine Fuel Filter Contamination

By Michael Jones
Senior Service Engineer, Propulsion

Dirty fuel is the main cause of engine fuel filter contamination. Although it's a difficult problem to isolate, airlines can take steps to deal with it, including auditing fuel suppliers to ensure that they are following applicable fuel handling requirements and replacing engine fuel filters more often.

Fuel contamination can take many forms, but the result is often the same: a fuel filter bypass indication that may cause delays if the pilot elects to return to ground or divert to have the fuel filter inspected or replaced. This article addresses contamination of the engine fuel filter.

BACKGROUND

In 2003, the International Air Transport Association (IATA) Technical Fuel Group formed a team comprising airlines, airframe manufacturers, and fuel suppliers to study the reasons behind an increase in the number of reported fuel filter impending bypass indications and more frequent filter replacements being reported by airlines. The team examined many reports of contaminated fuel filters but could not determine a single cause of the problem. The majority of the fuel filters examined were filled with silicates (i.e., dirt), sulfates, iron oxide (i.e., rust), and salts (see fig.1). The team could not draw a specific conclusion but suspected that the contamination was being uplifted with the fuel. The team also suspected that the fuel technically would pass the ATA 103 fuel handling specification for cleanliness.

An impending bypass indication will show when the differential pressure switch in the engine fuel filter is actuated (10.5 to 12.5 pounds per square inch on the CFM53-3 engine). On the Boeing 737, the FILTER light on the P5-2 panel and MASTER CAUTION indicator will illuminate when this differential pressure switch is actuated. The Boeing 757, 767, 777, and 747-400 will show an engine fuel filter message on the Engine Indicating and Crew Alerting System.

FUEL FILTER BYPASS INDICATION

Fuel filter bypass indications are required by the Federal Aviation Administration (FAA). In its publication *Airplane Turbofan Engine Operation and Malfunctions — Basic Familiarization for Flight Crews,* the FAA explains, "If the fuel filter at the engine fuel inlet becomes clogged, an impending bypass indication will alert the crew for a short while before the filter actually goes into bypass."

The filter and indication system are designed so that the mission can be completed under normal levels of particulate contamination in the fuel. Most impending bypass indications occur during the takeoff roll or climb because this is the phase of flight that typically has the highest fuel flow through the filter, and greatest delta pressure across the filter.

If a flight crew receives a fuel filter bypass indication during a flight, procedures do not

CONTAMINATION TRAPPED BY A FUEL FILTER
Figure 1

A visual inspection of a fuel filter reveals a variety of contaminants.

CONTAMINATED FUEL FILTER CAUSES LOSS OF POROSITY
Figure 2

When the engine fuel filter medium becomes clogged with contaminates, it loses its porosity, leading to a fuel filter bypass indication. This filter medium is loaded with silicates and sulfates.

The individual particulates found on fuel filters are very small, often less than 1 micron in size. However, these particulates become bound together on the filter medium and filter screen.

specifically call for a diversion or return to airport. It is up to the flight crew to return to ground, divert, or continue with the flight. If there are adequate alternate airports along the route of flight, and only a single engine fuel FILTER BYPASS light is illuminated, with no abnormal operation, the captain may make the decision to proceed with the flight. A fuel FILTER BYPASS light with any abnormal engine operation should be cause for a diversion. In addition, an immediate diversion should be performed if *both* engine bypass lights are illuminated or have illuminated during the flight.

In any case, it's important to keep in mind that the alert is an *impending* bypass indication: the filter can still handle several more grams of material before the bypass valve opens and it is unlikely an actual filter bypass would occur during that flight. At this point, if contamination gets past the filter, it is possible for the engine to shut down. However, Boeing has not had any reports of an engine shutdown due to dirt contamination.

ENGINE FUEL FILTER OUTER SCREEN AT 30X MAGNIFICATION

Figure 3

This filter screen is contaminated with particulates and a gum residue.

MICROBIAL CONTAMINATION IN A WING TANK

Figure 4

The brown-black debris on the bottom of this tank is made up of fungus and bacteria. Fuel microbial growth can clog fuel filters, causing the airplane fuel quantity indication system to read incorrect values, and eventually cause structural corrosion of the aluminum stringers and wing skin. Operators can greatly reduce the chance of microbial growth by draining water from airplane fuel tanks weekly and by testing for microbes annually.

SOURCES OF CONTAMINATION

Contamination can enter the airplane wing from either the uplifted fuel or through the fuel vent systems. Atmospheric dust storms could be contributing to filter contamination; however, Boeing has been unable to correlate engine fuel filter blockage with any airplane pneumatic system problems due to dust storms. If dust storms were contributing to filter contamination, Boeing would expect problems with the airplane bleed system or environmental control system packs.

The individual particulates found on fuel filters are very small, often less than 1 micron in size. However, these particulates become bound together on the filter medium and filter screen. Boeing believes that the sulfates, such as calcium sulfate dihydrate, which are water soluble and polar, are helping to bind these very small particulates together, preventing the material from passing through the filter. Filtration used in fuel uplift vehicles is typically between 0.5 and 1 micron absolute.

Locating the source of engine fuel filter contamination can be very difficult. If an airport is in the process of building or modifying a fuel hydrant system, airlines should ensure that the system is properly flushed before it is put into use. Large quantities of relatively large particulates are an indication that the filtration at an airport is not adequate.

CATEGORIES OF CONTAMINATION

An IATA Technical Fuel Group team is working to standardize the testing procedures for contaminated fuel filters. This procedure will be available from IATA later this year. One of the key efforts in this standardizing testing procedure was to categorize the types of contaminates found on a fuel filter. The IATA team has classified four categories of contaminants:

Category 1: Foreign Objects. This category is for any material found on the filter from a maintenance activity or degradation of the airplane or ground fuel system. Foreign objects include paint chips, paper, aluminum chips, sealant chips, composite materials, and O-rings and gasket materials (see figs. 2 and 3).

Category 2: Clays and Rust. Clays and dirt comprise very fine particulates that are black, brown, or reddish in color. They are most often associated with dirt in uplifted fuel. Poor filtration processes at airports is the most common source of the dirt. Rust is associated with oxidation of steel piping in either the uplift vehicle or the airport fuel distribution system.

Category 3: Gumlike Residues. This category is for shiny, slimy, jelly-like materials, including microbial contamination and oil and coke deposits (see fig. 4).

BOEING FUEL FILTER MAINTENANCE RECOMMENDATIONS

Figure 5

These are the official Boeing recommendations for scheduled maintenance for fuel filters, as cited in the relevant Maintenance Planning Data manual.

AIRPLANE MODEL	RECOMMENDED FUEL FILTER MAINTENANCE
717	No interval or check established
737 Classic	1C Check
Next-Generation 737	Fuel filter replacement at 6,000 flight-hours (FH)
747-400	Fuel filter replacement at 7,500 FH or 18 months (whichever comes first)*
757	Fuel filter replacement at 3,000 FH
767	Fuel filter replacement at 3,000 FH
777	Fuel filter inspection at 2,000 FH

Category 4: Unknowns. This category includes anything not listed in the first three categories. These materials may require additional laboratory procedures to identify.

Almost every filter examined by Boeing and other laboratories contains the following contaminates:

- Silicates, including clay and dirt with very small particulate sizes.
- Sulfates.
- Salts, primarily sodium chloride and potassium chloride.
- Iron oxides (rust from steel).
- Aluminum chips (due to fuel tank maintenance).
- Tank primer (due to fuel tank maintenance).
- Fibers (from rags left in the tank).
- Trace elements such as magnesium contained in soil.
- Microbial contamination.

Less frequently, filters contain the following contaminates:

- Grease.
- Glycols from cleaning fluids or wing de-icing fluids.
- Polymer from airport water monitors. (This polymer has been found on a number of engine fuel filters, but it is not known whether it has caused any problems with the engine fuel system.)

IMPROVED METHODS ON THE HORIZON

For many airlines, the current fuel filtration methods at airports are not adequate to prevent airplane fuel filter contamination for the replacement interval recommended by engine manufacturers. But new technologies are emerging that will provide more accurate assessments of the amount of particulates and water in uplifted fuel.

For example, in-line optical devices may be able to alert operators to potential problems with fuel contamination before the fuel is pumped into the airplane. These devices measure the index of refraction: if the fuel contains particulates or water, the index of refraction changes and the system will notify the airport ground crew to take action. It is anticipated that optical devices could detect particulates a few microns in size while fuel is

AIRPLANE MODEL	RECOMMENDED FUEL FILTER MAINTENANCE
DC-8	1C Check
DC-9	1C Check
DC-10	General Electric: No Interval — Fuel Filter Bypass “Clog” Indication System determines filter change Pratt & Whitney: 2A Check*
MD-11	1C Check
MD-80	1C Check
MD-90	1C Check

*Every 150 hours for the first 1,000 hours following airplane delivery or major airplane fuel tank repair.

flowing to the airplane. It may take several more years before this new equipment is installed at the majority of airports.

RECOMMENDATIONS

Because many instances of fuel contamination can be traced to uplifted fuel, it’s important that airlines ensure that their fuel suppliers are following proper fuel handling requirements by performing periodic audits of their facilities. The fuel supply should contain less than 0.5 milligrams of particulates per liter.

If an operator is experiencing a large number of air turnbacks or rejected takeoffs because of fuel filter bypass indications, it may want to consider replacing fuel filters more frequently than the recommended scheduled maintenance interval (see fig. 5). Many airlines are replacing fuel filters at 2,000 hours or fewer, compared to the published scheduled maintenance intervals of up to 7,500 hours. If an airline suddenly has filter contamination problems on many airplanes, it is a sign of poor filtration at an airport facility and the airline should investigate the fuel suppliers.

SUMMARY

It’s important that airlines work with their fuel suppliers to ensure that local fuel handling procedures are being followed. If the source of the contamination cannot be found, the only alternative is to replace the fuel filters more frequently.

For more information, please contact Michael Jones at michael.d.jones@boeing.com.

ALL GROUND PERSONNEL WHO WORK NEAR AIRPLANES NEED TO KNOW THE LOCATIONS OF ENGINE INLET HAZARD ZONES.

Preventing Engine Ingestion Injuries When Working Near Airplanes

By Fred Zimmer
Lead Engineer, Service Engineering, Propulsion

History has shown that failure to observe proper safety precautions, such as good communication and awareness of the hazard areas in the vicinity of an operating jet engine, can result in serious injury or death. The risk of ingestion can be prevented with appropriate training and adherence to the safety precautions and hazard areas outlined in the applicable Airplane Maintenance Manual (AMM) chapter 71 procedures. Although this article is written primarily about 737 engine hazard areas, the risk of ingestion exists on all airplane models.

Airline and airport employees work around commercial airliners every day throughout the world without incident. However, neglecting to stay out of the engine inlet hazard areas or complacency working near operating engines can result in severe injury or death.

There have been 33 reported ingestions of personnel into an engine on 737-100/-200 airplanes since 1969. Several of these ingestions caused serious injuries and one resulted in a fatality. There have also been four reports of fatal ingestion incidents on 737-300/-400/-500 and Next-Generation 737 airplanes. The most recent fatalities occurred in 2006.

This article outlines the importance of avoiding engine inlet hazard areas when working on or near operating engines and provides recommendations for preventing engine ingestion.

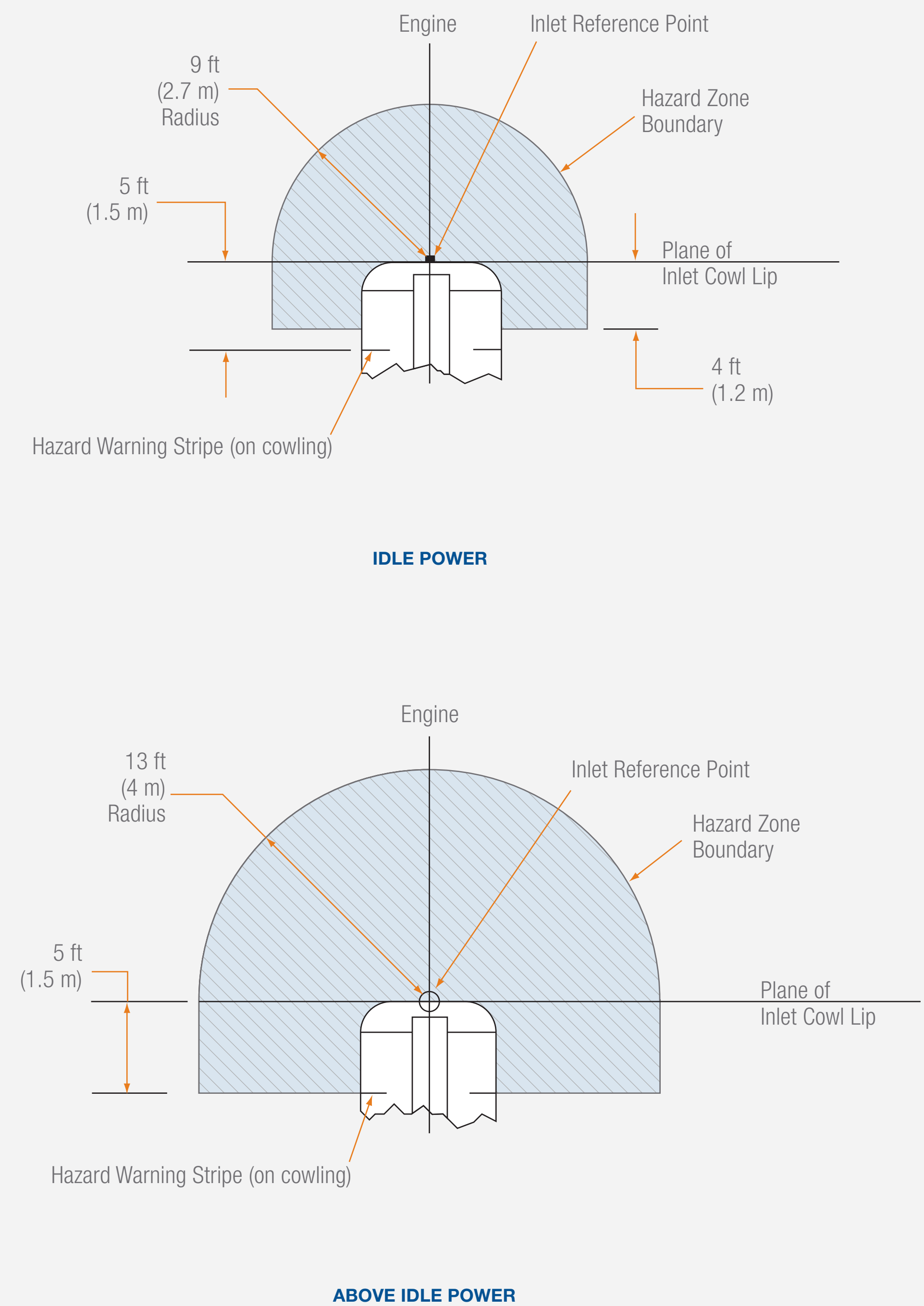
THE DANGERS OF ENGINE INGESTION NEAR AIRPLANES

When a jet engine operates, it creates a low-air-pressure area in the inlet. This low-pressure area causes a large quantity of air from the area forward of the inlet cowl to go into the engine. The air that is near the inlet cowl moves at a much higher velocity than air that is farther from the inlet. As a result, the amount of engine suction is small until one nears the inlet, where the suction increases significantly.

Because of the dangerous pull of engine suction, it is important for ground personnel working near commercial airliners with operating engines to stay at a safe distance from the forward engine area to avoid the possibility of injury or death. This is particularly important on airplanes with low ground clearance, including the 737. Additionally, there is a much greater potential for serious or fatal injuries if ingestion into a CFM56 engine occurs because the CFM56 does not have

737-100/-200 AND 737-300/-400/-500
ENGINE INLET HAZARD ZONES
Figure 1

Engine inlet hazard zones for the 737-100/-200 and 737-300/-400/-500 at idle power (top) and above idle power (bottom).



inlet guide vanes. The JT8D has 19 stationary inlet guide vanes that have provided ingested personnel some protection from fatal contact with the rotating fan.

HIGHLIGHTING THE HAZARD

Preventing engine ingestion starts with ensuring that people who work around airplanes are aware of the dangers associated with getting too close to an operating engine. There are four primary ways to highlight these dangers:

- Clearly define and graphically illustrate the engine inlet hazard zone.
- Use recommended warning signs.
- Communicate the dangers of working near operating engines and institute and enforce safe procedures.
- Implement a program of ongoing awareness.

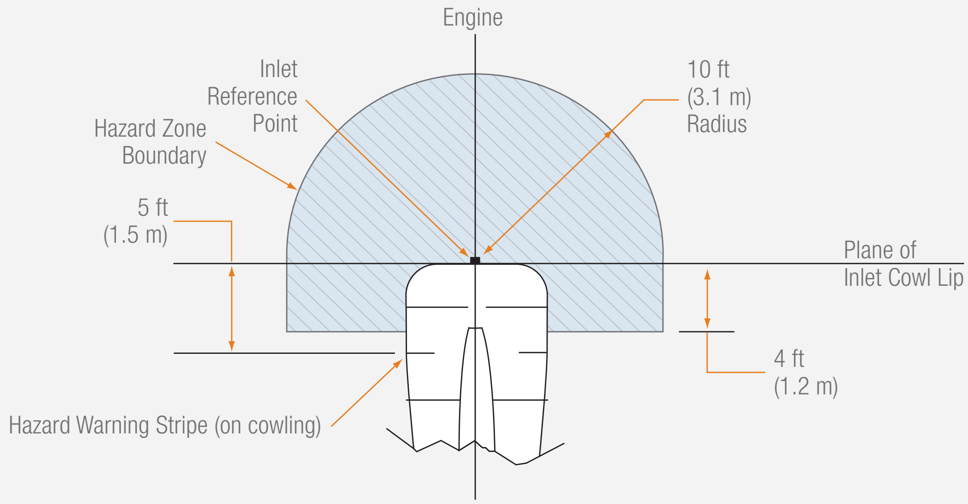
Clearly define and graphically illustrate the engine inlet hazard zone.

All ground personnel who work near airplanes need to know the locations of the engine inlet hazard zones with engines at idle and above idle thrust (see figs. 1 and 2). Definitions for these zones are published in the AMMs.

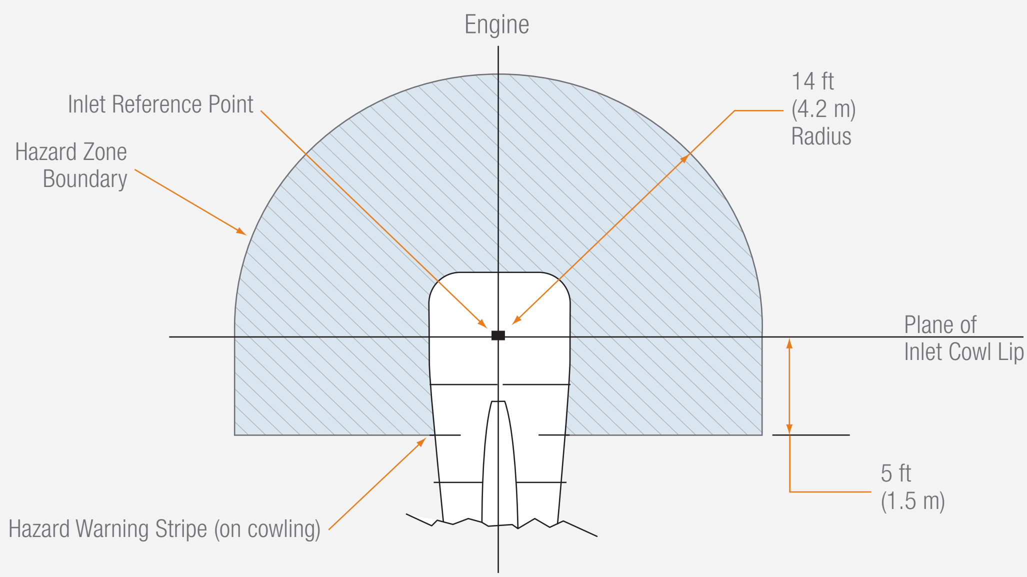
Ground personnel working near the power plant during engine operation must also be aware of the hazard areas that are aft of the inlet cowl lip. This hazard area extends completely around the outer diameter and to the forward end of the power plant. After the engine is stopped, workers should be sure the fan is stopped before going near the air inlet. Ground personnel should stay outside of the inlet hazard areas for at least 30 seconds after the start lever is put in the "cutoff" position. Ground personnel should be informed of the start lever position through communication with the crew on the flight deck.

NEXT-GENERATION 737
ENGINE INLET HAZARD ZONES
Figure 2

Engine inlet hazard zones for the Next-Generation 737 at idle power (top) and above idle power (bottom).



IDLE POWER

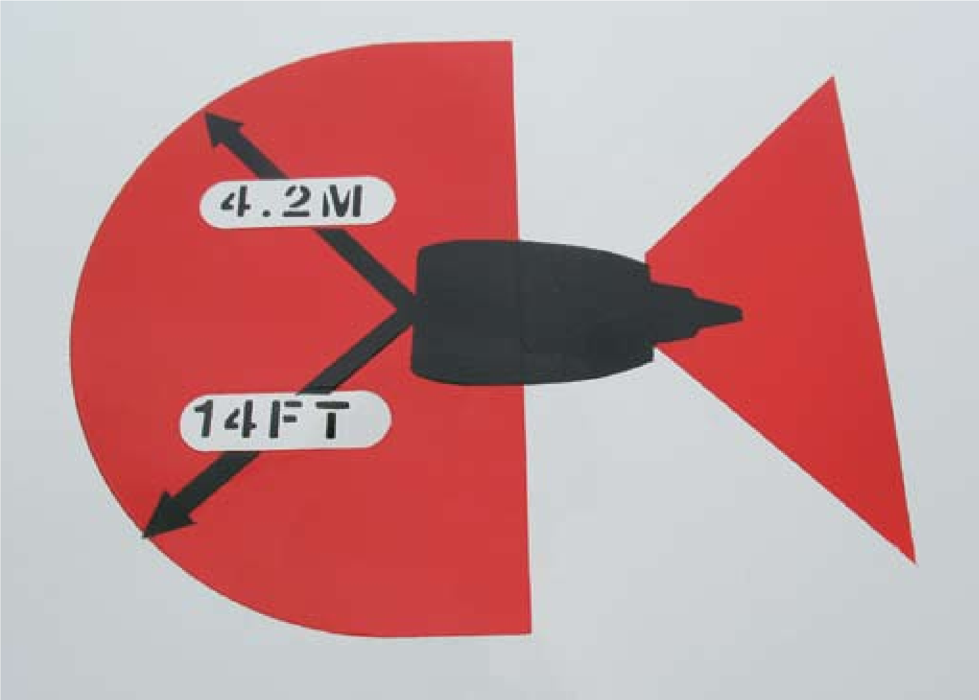


ABOVE IDLE POWER

HAZARD-AREA WARNING DECALS

Figure 3

These hazard-area warning decals are located on both left and right engine nacelles. For the 737, hazard-area warning stripes and decals have been applied to all CFM56 engine nacelles prior to delivery. Inlet hazard-area warning stripes and decals were applied to all JT8D engine nacelles prior to delivery beginning with airplanes delivered in May 1984. Boeing Service Bulletin 737-11-1010, Revision 1, dated June 21, 1985, provides for retrofit application of warning stripes and decals on JT8D engine nacelles delivered prior to this date.



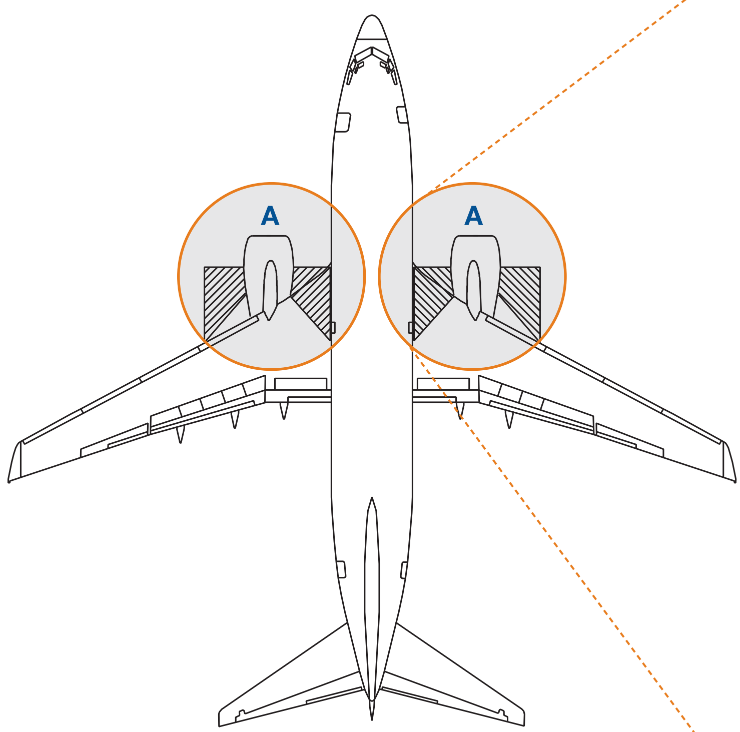
Use recommended warning signs.

All 737-300/-400/-500 and Next-Generation 737 airplanes at delivery have Boeing-applied hazard-area red warning stripes, above-idle hazard-area decals, and "no-entry" decals applied to the engine nacelles (see fig. 3). Similar hazard-area warning stripes and decals were also applied to all 737-100/-200 airplanes beginning with Line Position 1020, which was delivered in May 1984. For 737-100/-200 airplanes prior to Line Position 1020, hazard-area warning stripes and decals can be applied per Boeing Service Bulletin 737-11-1010 Revision 1, dated June 21, 1985.

To further promote awareness of engine inlet hazard zones and provide ground personnel with a visual definition of the zones, some operators have painted engine inlet hazard zone boundaries on ramp surfaces at parking locations. If ramp surfaces are painted, Boeing recommends only painting hazard boundaries for above idle power to prevent any confusion that may result from different boundary areas. Operators also need to be aware that different hazard boundaries exist for 737-100/-200/-300/-400/-500 than for Next-Generation 737 airplanes. Any painted ramp surfaces should reflect the larger above idle power Next-Generation 737 hazard boundary area if operators have multiple 737 derivatives in their fleets. Procedures should be established to ensure that airplanes are correctly parked in relation to the painted hazard zone boundary so that the inlet reference point of each engine is within the recommended tolerance. Additional information regarding hazard boundaries painted on ramp surfaces can be found in Boeing Service Letter 737-SL-71-028A, dated April 25, 2002.

737 ENTRY/EXIT CORRIDORS
Figure 4

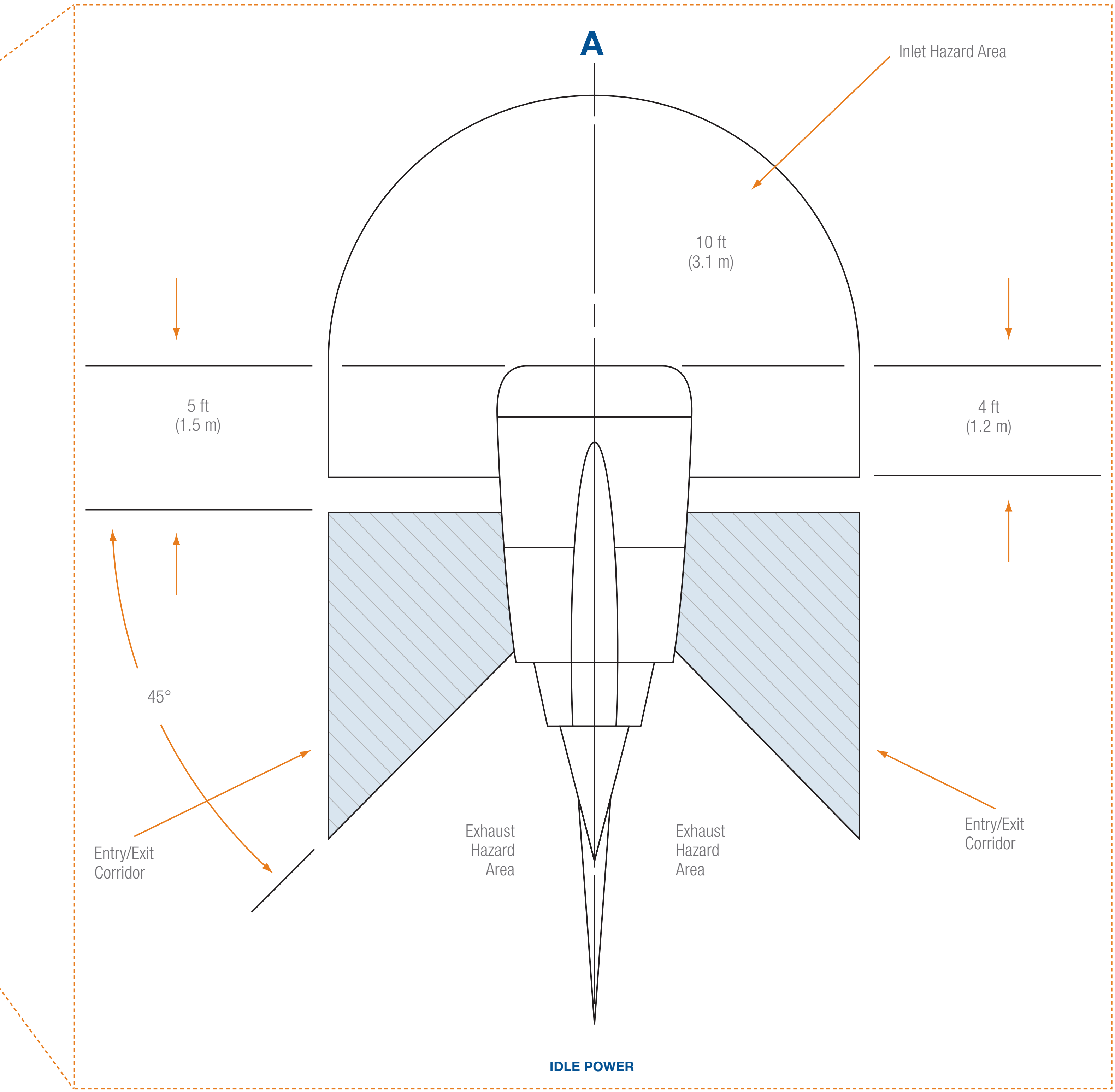
Ground personnel must use only the designated entry/exit corridor when it is necessary to be near an operating engine. (The Next-Generation 737 is shown; 737-100/-200/-300/-400/-500 entry corridors are similar.)



Communicate the dangers of working near operating engines and institute and enforce safe procedures. Operators should emphasize the need for ground personnel to be constantly aware of the engine hazard zones and clearly communicate that carelessness near an operating engine inlet can be fatal. Operators should also emphasize that when ramp surfaces are slippery near the inlet hazard zone boundary, additional precautions, such as cleaning the ramp, will be necessary to provide for worker safety. In addition, if surface winds are gusty and greater than 25 knots, the dimensions defining the inlet hazard zone boundary should be increased by 20 percent.

If it is necessary for ground personnel to be near the engine during an engine operation (such as during an idle leak check or to disconnect the ground air cart), they should make sure that the engines are at minimum idle and use only the entry/exit corridor to enter and exit the fan case area (see fig. 4 for Next-Generation 737 airplanes). Similar 737-100/-200/-300/-400/-500 entry corridors are identified in the applicable AMM. Inlet screens and a Boeing-approved personnel safety harness (part number F8023912) can be used for additional protection. Correct use of the safety harness is described in the AMM.

Implement a program of ongoing awareness. Boeing recommends that operators ensure that their personnel are trained properly and alerted to the appropriate precautions that need to be taken to prevent injuries when working



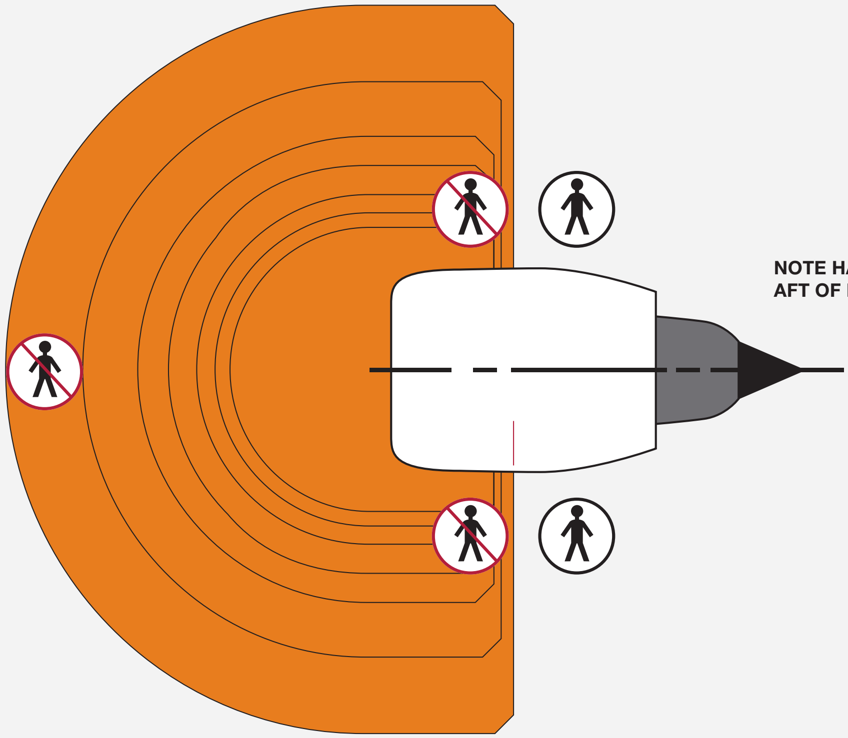
A
Inlet Hazard Area
10 ft
(3.1 m)
5 ft
(1.5 m)
4 ft
(1.2 m)
45°
Entry/Exit
Corridor
Exhaust
Hazard
Area
Exhaust
Hazard
Area
Entry/Exit
Corridor
IDLE POWER

INLET INGESTION WARNING POSTER

Figure 5

A warning poster, available from Boeing, reminds ramp and maintenance workers about the dangers of engine ingestion.

INLET SUCTION FORCES ARE HARDLY NOTICEABLE BEYOND THE INLET HAZARD AREA BUT INCREASE DRAMATICALLY WITH EACH STEP INTO THE HAZARD AREA.



BE AWARE OF ENGINE INLET HAZARD AREA. ONE MISSTEP INTO THESE AREAS AND IT MAY BE YOUR LAST.

DO

- Do know the proper hazard areas as stated in the maintenance manuals.
- Do secure loose items on person or remove them.
- Do tread carefully, guard against tripping or stumbling.

DO NOT

- Do not wear loose clothing.
- Do not attempt to retrieve items in hazard area.
- Do not gesture with arms.

SEE IT ONLINE

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in the vicinity of an operating jet engine. Inlet ingestion warning posters are available from Boeing Field Service representatives (see fig. 5). For 737 operators, a videotape presentation regarding inlet ingestion warning, "737 CFM56 Engine Maintenance Safety" (catalog number VIDN931117), may be purchased through the Boeing subsidiary Alteon at www.alteontraining.com or info@alteontraining.com.

SUMMARY

By following published procedures and taking proper precautions, airlines can protect ground personnel from injury or death as a result of ingestion in an operating airplane engine. These precautions include clearly defining and illustrating the engine inlet hazard zone, using warning signs, communicating the dangers of working near operating engines, instituting and enforcing safe procedures, and implementing a program of ongoing awareness.

For more information, please contact Fred Zimmer at frederick.g.zimmer@boeing.com.


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