



*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

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

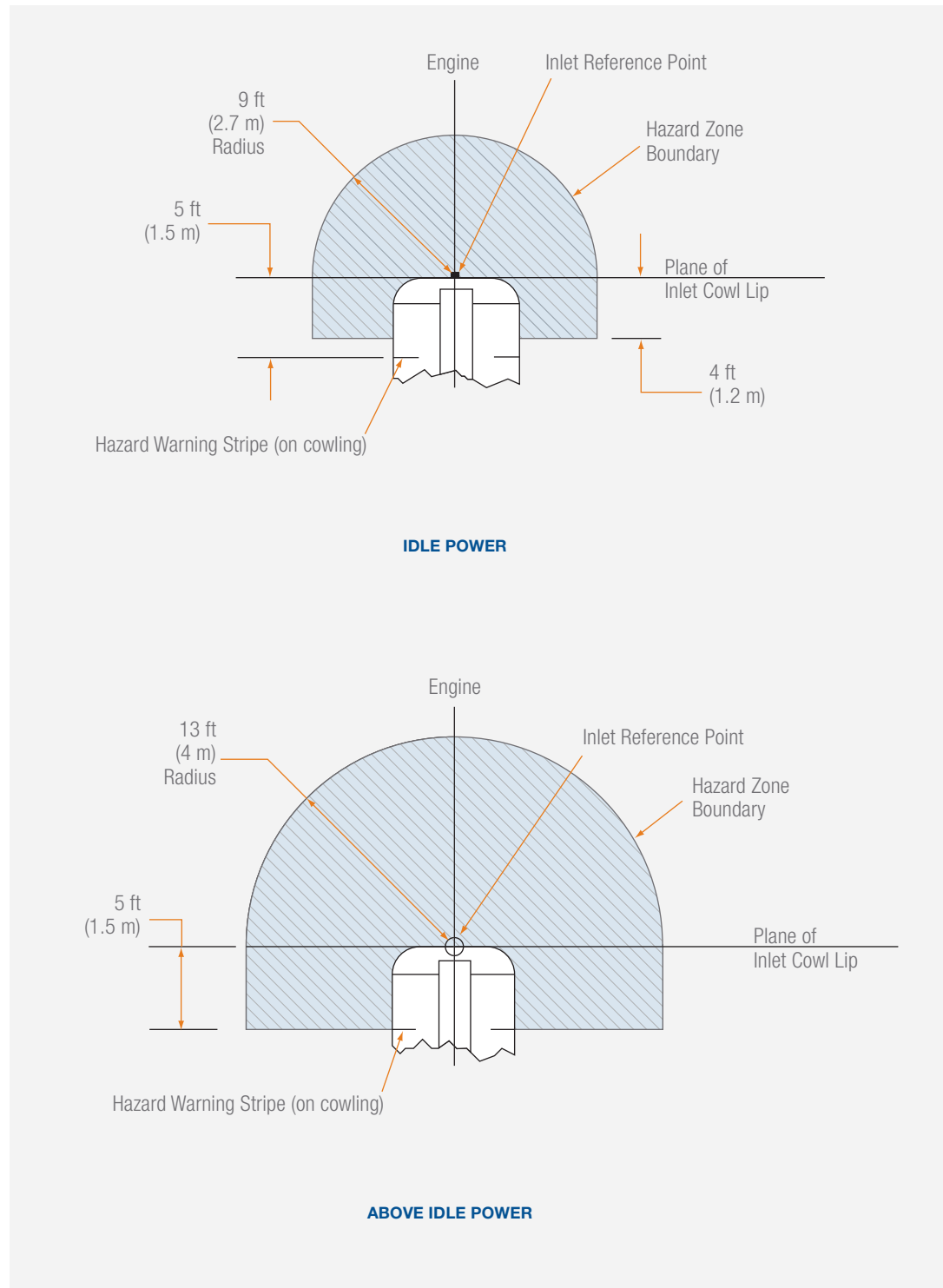
Preventing engine ingestion starts with ensuring that people who work around airplanes are aware of the dangers associated with getting too close to an operating engine. There are four primary ways to highlight these dangers:

- 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.

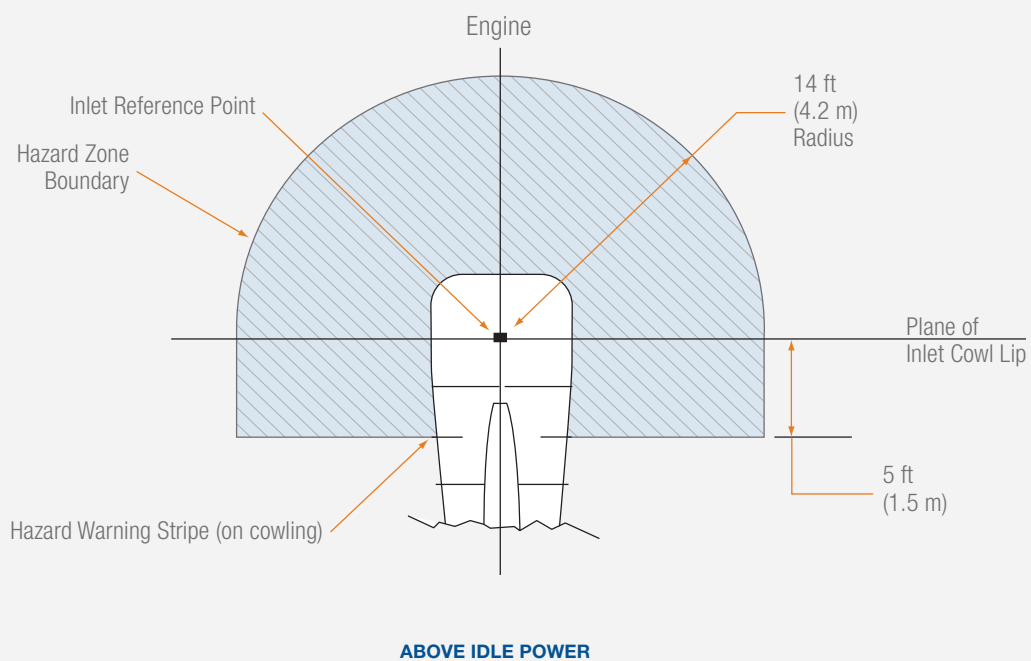
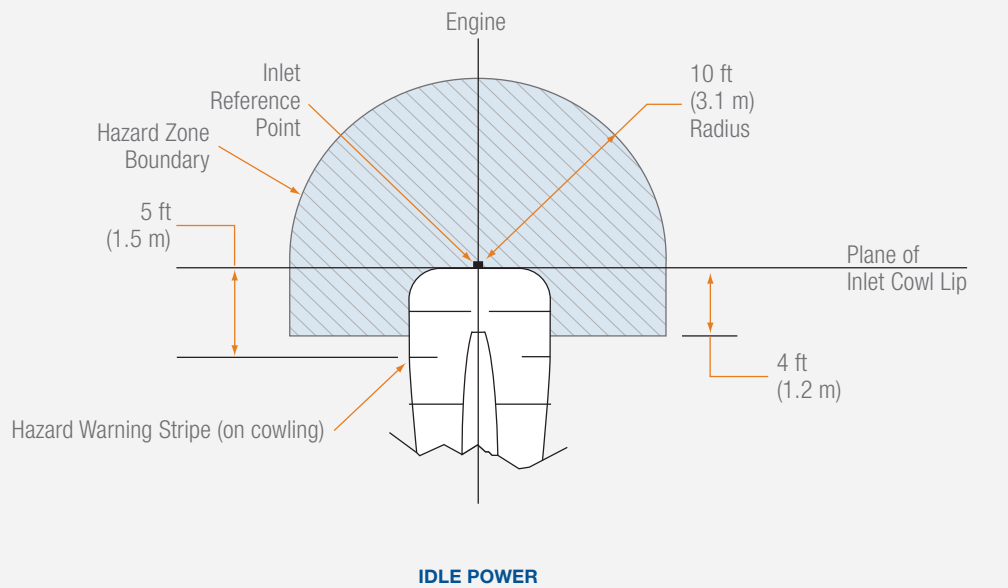
Ground personnel working near the power plant during engine operation must also be aware of the hazard areas that are aft of the inlet cowl lip. This hazard area extends completely around the outer diameter and to the forward end of the power plant. After the engine is stopped, workers should be sure 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).

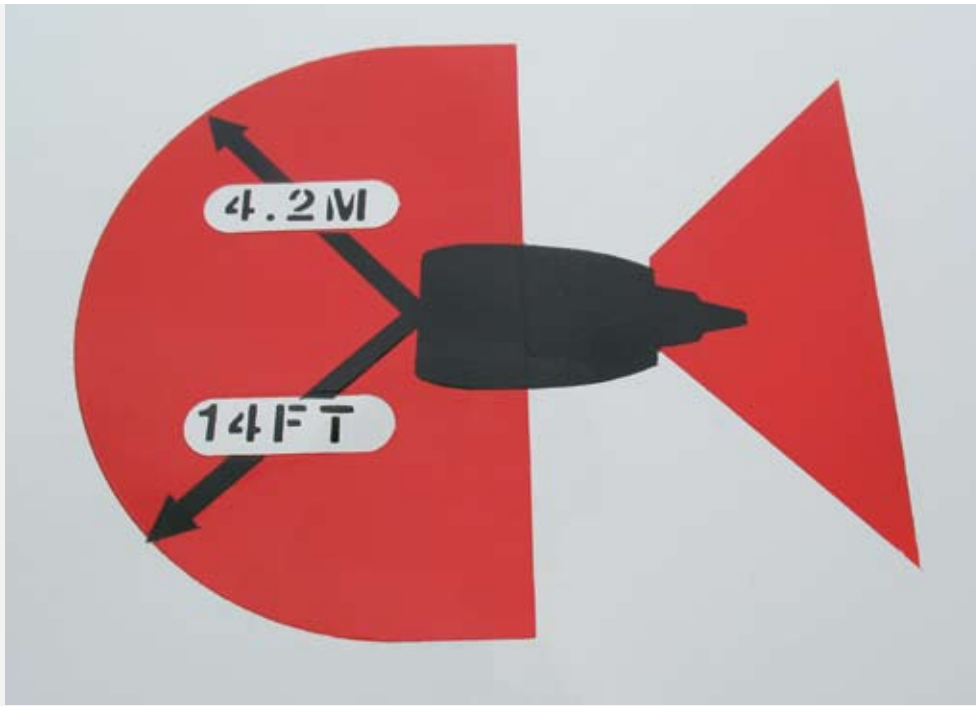




HAZARD-AREA WARNING DECALS

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.

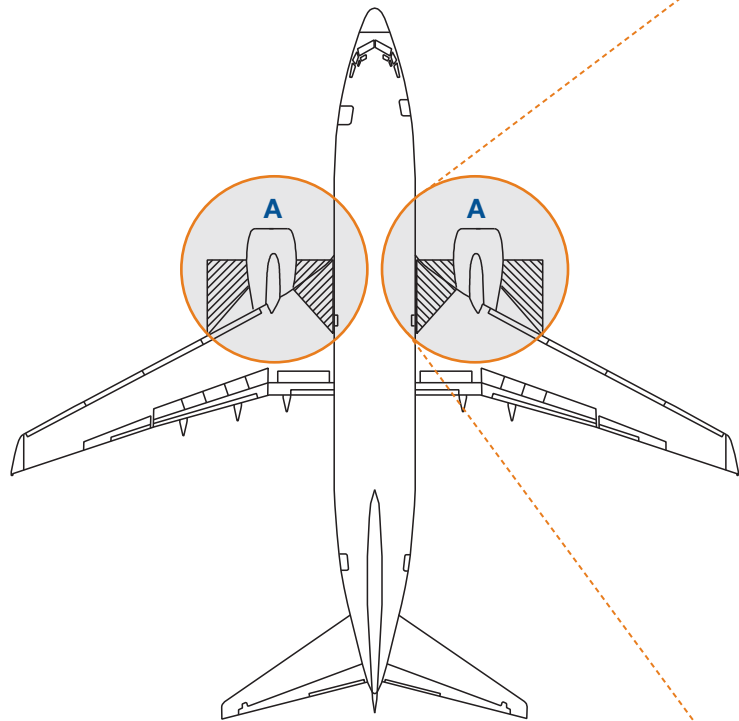
To further promote awareness of engine inlet hazard zones and provide ground personnel with a visual definition of the zones, some operators have painted engine inlet hazard zone boundaries on ramp surfaces at parking locations. If ramp surfaces are painted, Boeing recommends only painting hazard boundaries 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.)



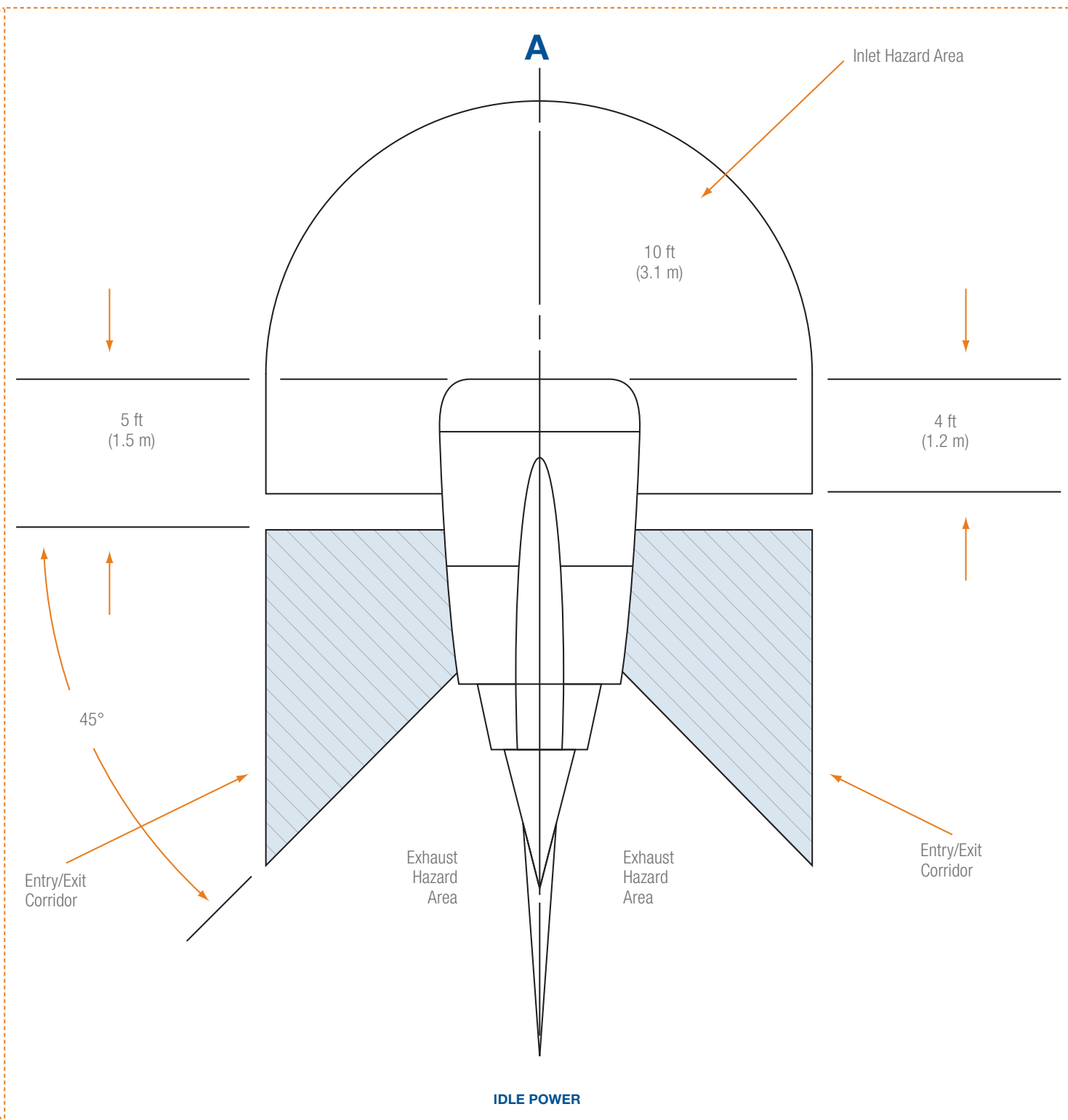
Communicate the dangers of working near operating engines and institute and enforce safe procedures. Operators should emphasize the need for ground personnel to be constantly aware of the engine hazard zones and clearly communicate that carelessness near an operating engine inlet can be fatal. Operators 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



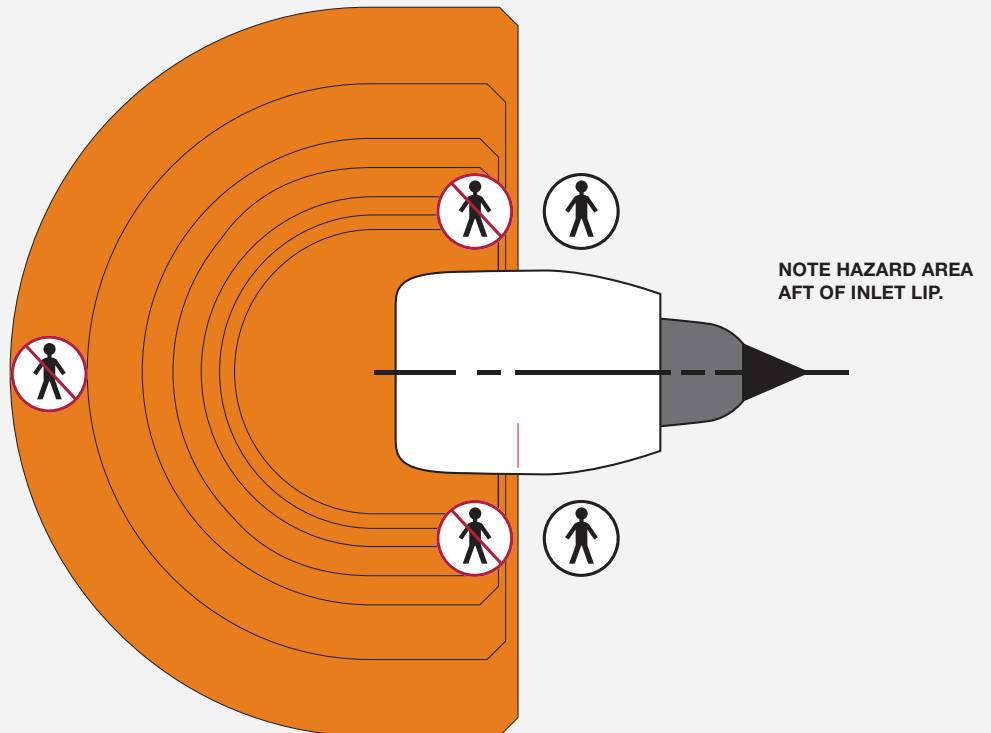
INLET INGESTION WARNING POSTER

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

To view enhanced media related to this article, visit www.boeing.com/commercial/aeromagazine

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. **A**