

Commercial airplanes
can safely use
runways with arresting
systems designed
for military use.



Commercial Operations on Runways with Arresting Systems

A number of airports throughout the world have joint commercial-military operations. Runways at these airports often are equipped with arresting gear systems (such as cables or barriers/nets) for tactical military aircraft to use. These systems pose a potential damage and safety hazard to commercial airplanes that use the same runways. Airports and airlines can take steps to help ensure safe commercial operations under such circumstances, including writing airport procedures specifically for commercial airplane operations, modifying existing arresting systems, reducing declared landing and takeoff distances, and increasing inspections of airplanes with nosegear spray deflectors.

By **Brad Bachtel**, Manager, Airport Compatibility Engineering

Of the nearly 36,000 airports around the world that are classified as civil, military, or joint-use, approximately 3,800 are used for scheduled commercial operations. Worldwide, approximately 2,500 aircraft arresting systems are installed on runways in 74 countries. Approximately 400 airports with arresting gear cable have reported commercial airplane traffic. If the nosegear spray deflectors used on some legacy commercial airplanes come in contact with the arresting systems, there is a possibility that the deflectors could shatter, creating foreign object debris (FOD). In extreme cases, the FOD could damage a critical airplane system.

This article is intended to help minimize the commercial operational impact at airports with runway arresting systems by describing the types of systems, operational concerns for airlines, and measures to help ensure safe commercial operations.

TYPES OF AIRCRAFT ARRESTING SYSTEMS

The three basic systems used to arrest aircraft are aircraft arresting barriers, aircraft arresting cables, and engineered materials arresting systems. The first two systems are primarily military systems used for

tactical aircraft, such as fighter and attack jets, but they are also found on joint-use runways. The third system is used at commercial airports that do not have sufficient safety areas at the end of the runway. (See “U.S. and International Aircraft Arresting Systems” on page 23.)

Aircraft arresting barriers. These devices, which do not depend on arresting hooks on aircraft, stop an aircraft by absorbing its forward momentum in a landing or aborted takeoff overrun. These systems are most commonly net devices (see fig. 1), but they also include older devices that catch the main gear struts. The barriers typically are

Figure 1: Barrier net

Arresting barriers, such as this net system, stop an aircraft by absorbing its forward momentum in a landing or aborted takeoff overrun.

- 1 Auxiliary Energy Absorber
- 2 Stanchion
- 3 Anchor Strap
- 4 Net Webbing
- 5 Runway Overrun Area
- 6 Main Energy Absorber

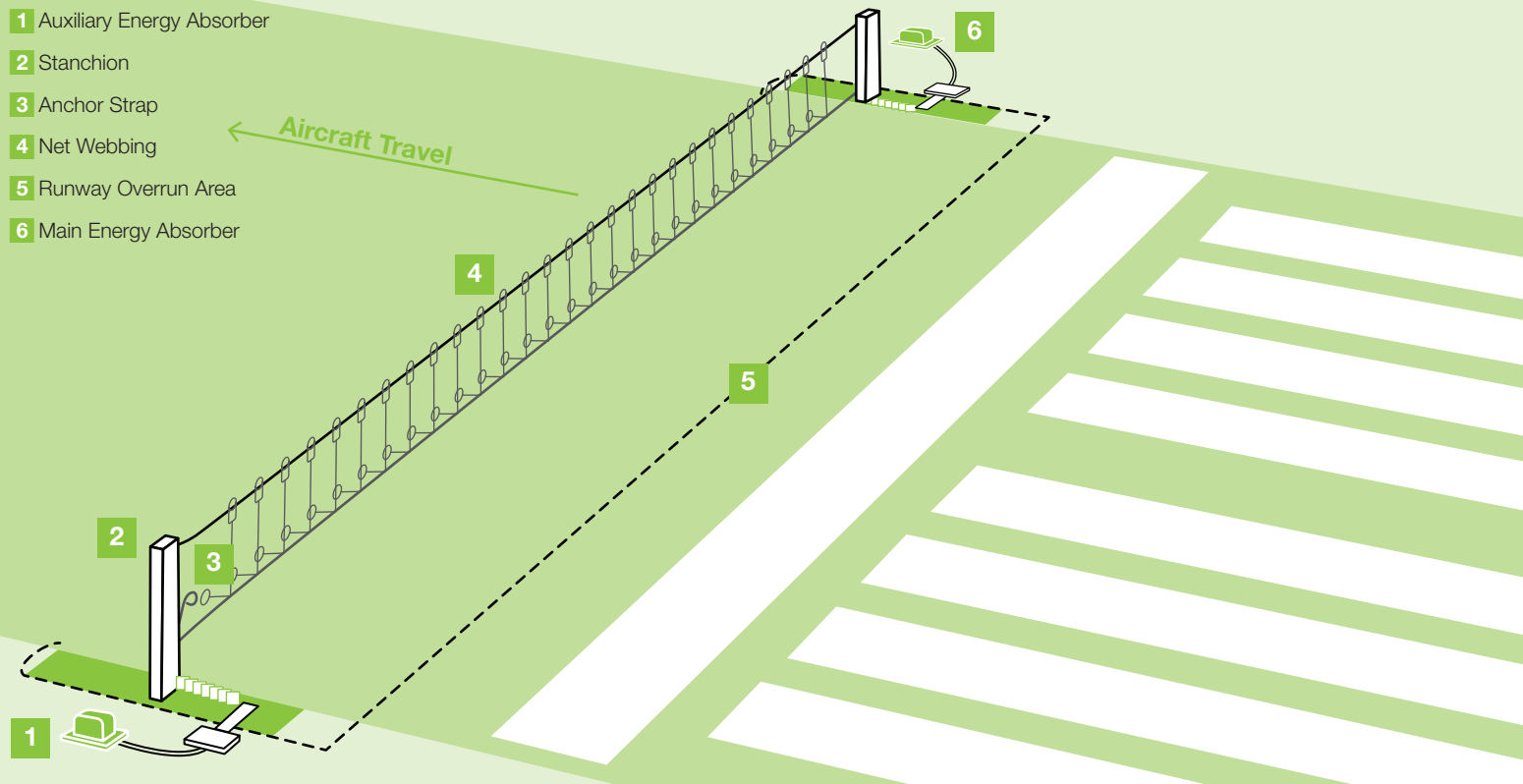


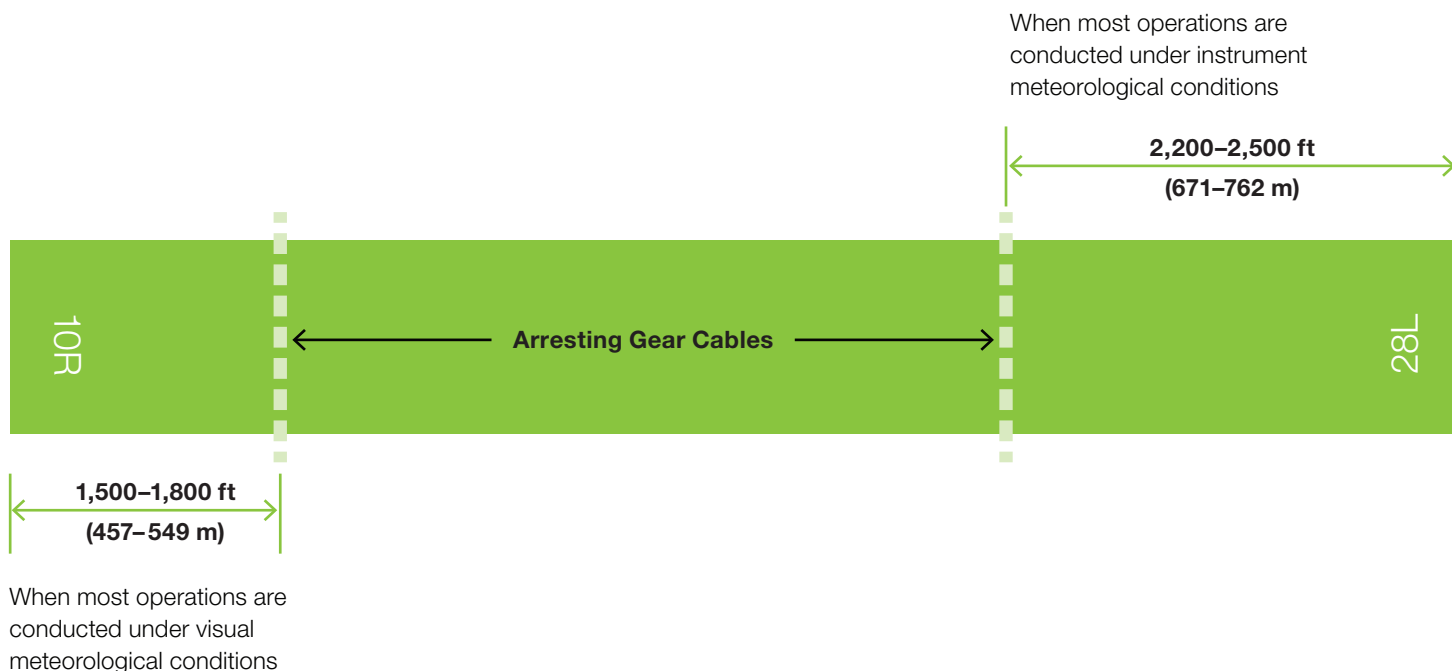
Figure 2: Arresting cables

Arresting cables are engaged by an arresting gear hook on the landing aircraft.



Figure 3: Typical arresting gear cable installation locations

At this airport, an aircraft operating on runway 10R would use the cable at the far end for both landing and aborted takeoff unless the aircraft had an emergency, at which point the arresting gear nearest the approach end of the runway would be used.



located in the overrun of the runway, are unidirectional, and can have collocated or interconnected arresting cables as part of their configuration.

Aircraft arresting cables. Arresting cables span the width of the runway surface and are engaged by the aircraft arresting gear hook (see fig. 2). Cables are typically 1 to 1.25 inches (2.5 to 3.2 centimeters) in diameter and suspended 1.5 to 3 inches (3.8 to 7.6 centimeters) above the pavement surface by rubber donuts 6 inches (15.2 centimeters) in diameter. Used primarily by military aircraft built in the United States and Europe, arresting cables have been used by the military since the late 1920s on aircraft carriers and land-based runways. While commercial airplanes have become engaged or tangled in arresting cables, these occurrences are rare.

Three main factors determine where cables are located on runways:

1. Engagement direction.
2. System runout.
3. Meteorological condition.

The engagement direction is the anticipated direction from which an aircraft will engage the cable. The system runout is the distance from the original cable location to the location at which the aircraft stops, which is typically 950 to 1,200 feet (290 to 360 meters). The meteorological condition is whether the system is used under visual meteorological conditions or instrument meteorological conditions (see fig. 3).

The installation criteria for cable systems on commercial runways are identified in the U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5220-9A, *Aircraft Arresting Systems for Joint Civil/Military Airports*. The location of the cable is marked on the runway by a series of reflective discs 10 feet (3 meters) in diameter painted “identification yellow.” These discs are laid out with 30 feet (9.1 meters) between centers and extend the full width of the runway (see fig. 2). (See the definition of *location identification* in “Common terms” on page 20.)

Engineered materials arresting systems (EMAS). EMAS, which are constructed of high-energy-absorbing materials of specific strengths, are located in the safety area, or overrun, of the runway. They are designed to crush under the weight of commercial airplanes as they exert deceleration forces on the landing gear. Since EMAS are located in the overrun area of the runway, the EMAS do not affect the normal landing and takeoff of airplanes. More information concerning EMAS is in FAA AC 150/5220-22B, *Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns*.

OPERATIONAL CONCERNS FOR AIRLINES

Airlines may have concerns about operating commercial airplanes on runways with aircraft arresting systems. These concerns include airplane nosegear interference, trampling of the arresting cable, adjustments to declared distances, dealing with arresting barriers, runway availability, airplane maintenance, and unintentional engagement of an arresting system.

Figure 4: Nosegear device

An MD-80 type is equipped with a combination nosegear spray-FOD deflector for normal operations. The ground clearance of this deflector is 0.75 to 1.5 inches (1.9 to 3.8 centimeters).



Common terms

Arresting Gear Cable Status:

- **Derigged** — The cable is removed from the runway surface and is not an operational concern.
- **Out of battery** (slack cable) — The cable is extended across the runway but is not under tension.
- **Rigged and down** — The cable is under tension across the runway but not elevated off the surface by use of rubber donuts (BAK-9/-12) or rubber elevation arms (BAK-14 or Type H modification).

- **Rigged and up** — Also referred to as the gear being “in battery.” This means the cable is under tension across the runway and elevated off the surface by use of rubber donuts (BAK-9/-12/-13) or rubber elevation arms (BAK-14 or Type H modification).

BAK — U.S. designation for a barrier arresting system. Non-U.S. arresting systems carry other designations. (See “U.S. and International Aircraft Arresting Systems” on page 23.)

Cycle time — A measure of time between engagement of an aircraft and the point when the arresting system is certified fully operational and ready for another engagement.

Location identification — A description identifying the location of arresting systems by the approach or departure end, runway designation, and position in hundreds of feet from the threshold. For example, the location identification “extended runout BAK-12 at +1,500 on approach runway 36” indicates a 1,200-foot (366-meter) runout BAK-12 arresting system located 1,500 feet (457 meters) beyond the threshold of runway 36.

Reset time — The time required to ready the arresting system for another engagement after aircraft release. (This does not include time to disengage the aircraft from the arresting system but does include the time required to inspect and certify that the system is fully operational.

Figure 5: Adjusting declared distances

In this example of adjustments to declared distances, an 8,000-foot (2,438-meter) runway could be reduced to 5,000 feet (1,524 meters) of usable runway length for each of the following declared distances: takeoff distance available, takeoff runway available, accelerate stop distance available, and landing distance available.

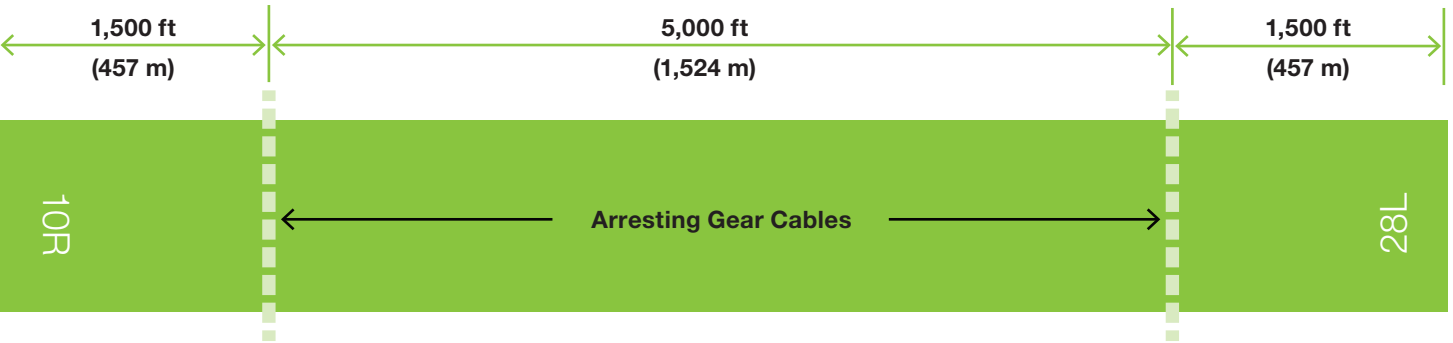


Figure 6: Examples of reduced runway lengths on weight

If the distance between the threshold and the cable is not used, the remaining runway can substantially reduce the available payload on 767-300ERF and 737-800 operations.

Airplane	Airfield Length ft (m)	Takeoff Weight lb (kg)	Weight Loss lb (kg)
767-300ERF	8,000 (2,438) 5,000 (1,254)	378,000 (171,458) 308,000 (139,707)	70,000 (31,752)
737-800	8,000 (2,438) 5,000 (1,254)	174,000 (78,926) 140,300 (63,640)	33,700 (15,286)

Nosegear interference. Some Boeing early model commercial airplanes have unique nosegear devices to deflect either spray or FOD. DC-9s, MD-80s, MD-90s, and 717s are equipped with nosegear spray-FOD deflectors (i.e., DC-9s having chine tires or the 717 that can have the outboard deflector and support missing). The ground clearance of this deflector is 0.75 to 1.5 inches (1.9 to 3.8 centimeters) (see fig. 4). Because most arresting cables are 1 to 1.25 inches (2.5 to 3.2 centimeters) in diameter and suspended in the center of rubber donuts that are 6 inches (15.2 centimeters) in diameter, nosegear deflectors are at risk of being damaged if a donut is struck.

Typical installation is for the rubber donuts to be approximately 6 feet (1.8 meters) apart, starting 3 feet (0.91 meters) from the runway centerline on runways 200 feet (61 meters) or less in width. For runways wider than 200 feet (61 meters) or that have the additional system to raise/lower the cable, the donuts are placed 8 feet (2.4 meters) apart, starting 4 feet (1.22 meters) from the runway centerline. To minimize potential damage to the nosegear deflectors, airplanes with such attachments should

slow-taxi over the cable, avoiding the donuts (if the cable is raised). If the nosegear spray deflector is damaged and removed, in accordance with the FAA-approved airplane flight manual’s configuration deviation list, the airplane is limited to operating on dry runways until the deflector is replaced.

Trampling of the arresting cable. The 737 (excluding those with gravel deflectors), 747, 757, 767, 777, and 787 families can land and taxi over the arresting cable/donuts at any speed without exceeding design limit loads of the main and nose landing gears. However, because the nosegear load increases substantially when taxiing above 25 knots, it is recommended to taxi below 25 knots and initiate takeoff roll once past the cable if raised. Hard braking should be avoided while traversing the cable during taxi. If an operator considers the trampling, or rolling over, of a cable to be too rough on the airplane, the donuts that elevate the arresting cable above the runway surface can be moved to the sides of the runway during commercial operations. This allows the cable to rest directly on the pavement surface, minimizing the bump effect on the airplane.

It is important to note that the cable must be kept under tension, whether lying on the pavement or elevated by the donuts. Otherwise, the cable could be lifted by the airplane landing gear and contact the bottom of the fuselage or antennae located on the lower fuselage. (See definitions of *out of battery*, *rigged and down*, and *rigged and up* in “Common terms” on page 20.)

Adjustments to declared distances. Some airlines that operate on runways with arresting cables have reduced the available runway length by the distance from the approach end of the runway, or threshold, to the cable (see fig. 5).

If the distance between the threshold and the cable is not used, however, the remaining runway available for use substantially reduces the allowable payload on a 767-300ERF and 737-800 operation, based on the conditions of a standard day, optimal flap setting, zero wind, no obstacles, and zero slope (see fig. 6). This method of reducing available runway may be usable for a short-haul flight, but it is not a preferred long-term solution.

Figure 7: Retractable cable

A BAK-14 modification enables air traffic control personnel to remotely raise (left) and lower (right) an arresting cable.



Dealing with arresting barriers. Nets are located in the overrun area near the runway threshold. If the net is in the raised position at the lift-off end, it should be treated as an obstruction that has to be cleared by 35 feet (11 meters) in accordance with typical regulations, and an adjustment should be made to the takeoff runway available. There are rare situations in which a net has been located across the actual runway. If a net is lying on top of the runway, the airplane should not cross it.

Runway availability. A commercial airplane following a military aircraft in to land could experience a delay in landing if the military aircraft engages the arresting gear. The flight crew of the commercial airplane should expect to execute a missed approach while the military aircraft is removed and the arresting gear is reset. Typical cycle times for arresting gear can vary from 3 to 10 minutes depending on the type of system. (See definitions of *cycle time* and *reset time* in “Common terms” on page 20.)

Airplane maintenance. If the flight crew believes the airplane nosegear deflector has contacted one of the hard rubber donuts supporting an arresting gear cable, a visual inspection of the nosegear spray deflector should be conducted to verify whether it has been damaged. A similar visual inspection would apply if the flight crew thought that the cable had made contact with the belly of the airplane. For airlines that routinely operate on runways with arresting-gear cables, additional visual inspections may be conducted depending on the type of arresting systems installed and to what extent the airplane interacts with the system.

MEASURES TO HELP ENSURE SAFE COMMERCIAL OPERATIONS

The key to dealing with the presence of arresting cables on runways is coordination among the airline operator, the airport authority, and the agency having control of

the arresting system. Educating the various parties on the operational needs of commercial airplanes can alleviate many limitations. Six ways to minimize the impact of arresting systems located on runways used by commercial airplanes are:

- If the airport has parallel runways, normally only one of the two runways has the arresting system installed. Consider limiting commercial operations to the runway without the arresting system.
- Coordinate the permanent removal of the arresting system. The military aircraft using the runways may no longer need the arresting cable, which could be removed.
- Install a system to lower the arresting cable flush into a track on the runway (see fig. 7). This modification, referred to as BAK-14 or Type H, allows the air traffic control tower to remotely raise the arresting cable for military operations and lower it into a track flush-mounted on the runway for commercial operations.

Figure 8: Disconnecting an arresting cable

In some situations, an arresting cable can simply be disconnected and laid on the side of the runway during periods of commercial operations.



At the majority of joint-use airports in the United States, this modification has been made to the standard BAK-9/-12/-13 systems that previously were supported by rubber donuts. Worldwide, there are approximately 500 BAK-14 and 25 Type H systems installed. Roughly 95 percent of joint-use runways have BAK-14 or Type H modifications installed. (See the definition of *BAK* in “Common terms” on page 20.)

- Disconnect the cable and lay it on the side of the runway during periods of commercial operations (see fig. 8). Temporarily disconnecting the cable is a workable solution provided the scheduled commercial operations do not interfere with the flight schedule of military aircraft. Alternatively, the rubber donuts could be slid to the edge of the

runway so that the cable lies flat on the pavement but is still under tension. The airplane then can roll over the top of the cable.

- Although not considered an optimal solution, the runway length can be reduced. This is feasible if the runway is of sufficient length that the mission of the airplane can be achieved on the usable runway distance between arresting gears installed at each end of the runway. At a minimum, operators may consider reducing only the distance from the approach end of the runway to the gear.
- Operators may want to increase the frequency of maintenance inspection of the nosegear and lower fuselage areas for airplanes that routinely operate over arresting-gear cables.

SUMMARY

Commercial airplanes can safely use runways with aircraft arresting systems. Approximately 400 airports with arresting gear systems have reported commercial airplane traffic. Safe operation requires coordination among airline operators, airport authorities, and the agencies that control the arresting systems.

For more information, e-mail AirportCompatibility@boeing.com. 