# CRS Insights

Protecting Civilian Flights from Missiles
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On July 17, 2014, Malaysia Airlines Flight 17, a Boeing 777 en route from Amsterdam, the Netherlands, to Kuala Lumpur, Malaysia, crashed over eastern Ukraine after apparently being struck by a surface-to-air missile. The event has renewed congressional interest in protecting civilian aircraft from missiles, a topic of considerable interest in the context of protection against terrorist threats and risks to aircraft operated in conflict zones.

Consideration of Missile Protection Systems for Civilian Aircraft

The State Department has estimated that, since the 1970s, over 40 civilian aircraft have been hit by shoulder fired-missiles, causing 25 crashes and more than 600 deaths. Most of these incidents involved small aircraft operated at low altitudes in areas of ongoing armed conflicts, although some larger jets have also been destroyed. Notably, on April 6, 1994, an executive jet carrying the Presidents of Rwanda and Burundi was shot down while on approach to Kigali, Rwanda, and on October 10, 1998, a Boeing 727 was destroyed by rebels in the Democratic Republic of Congo. On November 28, 2002, terrorists launched two shoulder-fired missiles at an Israeli charter aircraft departing Mombasa, Kenya, the first time such an event took place outside of a conflict zone.

In the conference report on the Emergency Wartime Supplemental Appropriations Act, 2003 (P.L. 108-11), Congress directed the Department of Homeland Security (DHS) to establish a plan to develop anti-missile technology for commercial aircraft. The ensuing program concluded in FY2008, following operational testing and Federal Aviation Administration (FAA) certification of two prototype Directed Infrared Countermeasure (DIRCM) systems. These systems can be mounted on civilian airliners to defend against infrared-guided missiles, which home in on aircraft by sensing engine heat. To date, no U.S. airlines have installed DIRCM systems on their aircraft, citing concerns over lifecycle costs, estimated at over $2 billion annually for the U.S. passenger airline fleet. Israel is reportedly testing a similar system that it intends to deploy on commercial airliners.

It is unlikely that a DIRCM system would have offered protection against the attack that brought down Malaysia Airlines Flight 17, as this incident appears to have involved a radar-guided missile. The DHS missile-protection effort did not focus on protections against radar-guided missiles, as these are rarely possessed by terrorists and insurgent groups. There are only two known cases of civilian aircraft encounters with radar-guided surface-to-air missiles. On July 3, 1988, a radar-guided missile launched by the *USS Vincennes*, a U.S. Navy cruiser operating in the Persian Gulf, brought down Iran Air Flight 655. On October 4, 2001, a Siberia Airlines Tupolev 154 was shot down over the Black Sea near Crimea during a Ukrainian military exercise.

Other civilian airliners, such as Korean Airlines Flight 007—shot down by Russian forces on September 1, 1983—have been hit by air-to-air missiles launched by fighter jets. Like sophisticated surface-to-air missiles, many air-to-air missiles operated beyond visual range rely primarily on radar guidance and cannot be spoofed by DIRCM systems. DIRCM systems may provide some protection against an infrared-guided missile launched by a fighter jet, but they do not protect against the full array of military weapons that rely on other means of guidance.

Protections Around Airports

When operating at airports in conflict zones and other high-risk areas, civilian aircraft can use steep descents, rapid climbs, and tight takeoff and landing patterns to minimize time spent within range of smaller, man-portable surface-to-air weapons. However, such techniques do not assure safety. A DHL cargo jet making a steep climb while departing Baghdad, Iraq, on November 22, 2003, was struck by a

shoulder-fired missile but managed to return to the airport and make an emergency landing.

Technologies, including ground-based systems placed near airports, like Israel's iron dome and high-energy laser weapon systems, provide potential options for protecting landing and departing flights, although their use in this role has been limited and questions remain about their effectiveness. Another approach considered by DHS was to install a DIRCM system on an unmanned aircraft operated at high altitude above an airport to protect landing and departing aircraft from infrared-guided missiles. While such an approach could, in theory, provide some protection in close proximity to an airport, initial testing indicated that available DIRCM systems could not reliably defeat a shoulder-fired missile in this configuration, and consequently further development of the concept was scrapped.

Warnings Persist

Absent effective, low-cost measures to protect aircraft from shoulder-fired missiles and other threats, cooperative international efforts have focused on controlling exports of these weapons, enhancing security of weapons stockpiles, and destroying weapons in regions where there is a high risk of proliferation to terrorists. Since 2003, the State Department has worked with other nations to destroy more than 32,500 small missiles in over 30 countries.

Despite these efforts, FAA continues to warn aircraft operators of potential threats in high-risk areas, and in some cases bans flights by U.S. operators. Currently, FAA prohibits flights by U.S. operators in and near areas of Libya, Iraq, Somalia, Ethiopia, and Ukraine. FAA warns that the ongoing conflicts in Syria and in Afghanistan pose significant risks to civilian aircraft, although it does not specifically ban flights to these countries. FAA maintains a longstanding advisory for Kenya, warning of the possible use of shoulder-fired missiles to attack civilian aircraft. Similarly, FAA warns that aircraft operated below 15,000 feet over the Democratic Republic of Congo may come within range of shoulder-fired missiles and maintains an advisory regarding flights operating below 24,000 feet in Mali that may be targeted by insurgent activity. FAA also warns of potential dangers to aircraft operating below 24,000 feet over the Sinai Peninsula in Egypt, and has issued an advisory cautioning that terrorists in Yemen possess shoulder-fired missiles that may threaten flights landing and departing Sanaa International Airport.