

# 民航機反飛彈研發現況

邁 德

2006年8月10日，英國警方破獲企圖炸毀多架飛往美國民航機的攻擊案，恐怖份子計畫以不易被偵檢的「液體炸彈」發動自殺引爆，所幸警方即時偵破，否則造成慘重傷亡，將比911更為嚴重。

回顧2001年9月11日，暴徒劫持民航機成功撞擊目標，至今世人記憶猶新；因此各種針對民航機的反恐措施紛紛出籠，諸如：過濾旅客名單與身份、嚴格檢查託運與隨身行李(含液態與膠狀物)、強化駕駛艙門並加密碼鎖、加裝客艙影像監視器、飛行員配帶防身武器、搭載武裝空安人員....等等不一而足，造成民航業營運不便及班機時間大幅延宕，營運成本額外增高。

## 肩射飛彈威脅

然而恐怖份子的威脅，除了可以執行劫機、引爆、撞機之外，也可以採用地面攻擊的方式達到目的。目前最難以防範的是地對空「肩射飛彈」攻擊，因為此型飛彈的生產國多、數量難以計算、價格又低廉等；據保守估計，有超過20,000枚、每枚價格僅幾千美元（黑市軍火市場行情），根本無法管制其來源。再加上肩射飛彈的特性是：發射技巧簡單、重量輕(10-35磅)、單人即可操作、隱蔽性等，其攻擊威脅實在是令人防不勝防！

911恐怖事件的受害者美國，聯邦航空總署研析後指出：雖然沒有美國民航機遭到肩射飛彈攻擊，但自1970年至今，世界各地就有超過35架的民航機曾被攻擊，而且有24架墜毀，造成500多人喪生的慘劇。因此，應該防範未然，積極且不計代價的研發有效率的民航機反飛彈防禦系統。

以色列也是面臨恐怖威脅的主要國家之一。2002年11月，以色列一架波音757客機在肯亞(Kenya)遭到凱達恐怖組織的2枚SA-7型肩射飛彈攻擊，所幸迫降成功250名旅客無人傷亡；為此，以色列隨即進行反飛彈系統的研製計畫。

## 反飛彈系統研發

一般而言，飛彈攻擊的導引方式有三類，一是追熱尋標，二是半主動雷達導引尋標，三是所謂的「射後不理」自主雷達尋標。當飛機偵測到有飛彈來襲時，反飛彈的反制方法有三種，一是施放「熱燄誘餌」(flares)以誤導追熱尋標飛彈，二是施放「干擾絲誘餌」(Chaff)，以干擾半主動雷達及自主雷達尋標的飛彈；飛機進行反制時，通常是二種誘餌應同時施放，因為偵測雷達無法分辨來襲飛彈的種類。三是最原始的靠飛行員目視，並採大動作改變飛行路徑逃避。

對民航機反飛彈系統的研發而言，相關科技不是問題。因為軍機的反飛彈系統早已成熟運用多年，而且不像民航機，只有低空時遭到地對空飛彈的攻擊威脅；軍機還需考慮到地對空飛彈的長程與高高度攻擊，以及空對空飛彈的攻擊威脅。民航機唯一受到限制的是，無法採用大動作來改變其飛行路徑。

我們可以從美國與以色列的反飛彈系統研發，進一步觀察軍事科技如何運用在民航機上。美、以兩國研發反飛彈系統的共同特點是，全都採用自動偵測與發射雷射光或投放熱燄誘餌，飛行員不必操作系統與進行任何逃避動作；簡單的說，民航機只要完成反飛彈系統的安裝，飛行員不必接受任何訓練！

## 飛行衛兵系統測試

以色列的反恐對策最為積極，因而獨自研發產製「飛行衛兵」(Flight Guard)反飛彈系統。當有一枚追熱尋標飛彈來襲時，安裝在機上的「飛行衛兵」偵測器就會發現，隨即自動投放熱燄誘餌，用來誤導飛彈的追熱尋標器而無法攻擊飛機。

2006年2月15日，以色列航空公司成功地在客機上加裝「飛行衛兵」反飛彈系統，成為第一家配備反飛彈系統的民航公司，俾防範日益增高，並且針對以色列民航機攻擊的恐怖行動。

目前已有5架以色列民航機裝置該系統進行測試，若

測試一切順利，隨後還有29架民航機將陸續安裝。據估算，每套系統的價格約為一百萬美元。

## 捍衛戰警系統測試

2004年美國國土保安部撥款4,500萬美元給Northrop Grumman公司，俾研改軍事反飛彈系統供民航機使用。取名「捍衛戰警」(Guardian)的反飛彈系統，其感測器安裝在民航機的機腹末端，當偵測到肩射飛彈攻擊時，隨即發射雷射光以混淆飛彈的追熱尋標器，因而無法命中飛機。

2005年起開始進行「捍衛戰警」系統測試，先在美利堅航空公司停飛的一架波音767客機上執行線路安裝測試，並在兩架民航機，分別是西北航空客機及聯邦快遞貨機上進行飛行測試。

2007年1月16日，一架聯邦快遞貨機MD-10，首次在洛杉磯國際機場成功完成「捍衛戰警」反飛彈系統飛試；這是一連串系統測試的開始，一直到2008年3月止，將有9架聯邦快遞貨機進行飛試。若測試一切順利，預估每套雷射反飛彈系統的費用亦約為一百萬美元，以美國6,800架民航機而言，其採購費用將高達70億美元。

## 民航機反飛彈困境

雖然以色列一再強調「飛行衛兵」系統的可靠度，但在低空施放熱燄誘餌，萬一熱燄誘餌在著地前尚未燒成灰燼，仍有危害機場周邊裝備的風險，特別是油庫、加油車及停放的飛機等；因此，目前歐盟尚未同意加裝「飛行衛兵」的民航機在其機場落地。

至於美國，布希政府雖然鼓勵民航機加裝反飛彈系統的研發，卻同時提出疑問，不論是雷射光或熱燄誘餌，只能反制諸如「聖杯」(SA-7)的追熱尋標飛彈，若發動攻擊的是諸如「針刺」(Stinger)雷達導引尋標飛彈時，那該怎麼辦？因此，目前仍有改採以機場區域來進行反飛彈防衛的替代方案。

肩射飛彈的威脅已經造成航空業的營運隱憂，然而民航機全面加裝反飛彈系統還要等上好幾年。再從反飛彈系統的研發現況觀察，把軍事反飛彈系統直接改裝在民航機上，其可靠度雖尚待驗證，但技術上的問題並不大，只是採購所費不貲，並且還得考量後續的維修費用。綜合上述，民航機反飛彈攻擊的諸多困境，還得逐項一一突破呢！✈



# The Research and Development of Anti-missile Systems for Commercial Airliners

Hui-Min Wu

British police smashed a plot of blowing off several U.S.-bound commercial passenger jet airliners on 10 August 2006. The terrorists attempted to stage a suicide attack by using "liquid bomb" which are difficult to detect. Fortunately, the police have broken the conspiracy timely to prevent a disastrous tragedy which may be more serious than 9-11 attacks.

The September 11 suicide attacks in 2001 are still lingering freshly in people's memory today in which the terrorists hijacked commercial airliners and flew into their targets with success. As a result, various anti-terrorism measures for commercial airliners are adopted, such as filtering the lists and identity of passengers, screening check-in luggage and carry-on baggage (including liquid and jelly-like material), strengthening the door to flight deck and using password locks, installing cabin video cameras, pilots armed with weapons for self-defense, carrying armed security personnel, etc. All these measures have caused operational inconvenience and significant time delay, at the expense of extra operation costs.

## **The Threats of Shoulder-launched Missiles**

However, in addition to the means of hijacking, detonating explosives and aircraft crashing, terrorists may also resort to ground attacks to achieve their goals. The attacks by using ground-to-air shoulder-launched missiles remain to be the most difficult challenge in

terms of prevention so far, as there have been multiple countries that are capable of producing this kind of missiles which are innumerable to count and their price are relative low; a conservative estimate shows that there are more than 20,000 missiles in the black arms markets, at a cost of a few thousand U.S. dollars each. It is hard to control the supply sources. On top of it, the features of shoulder-launched missiles—simple launching skills, light weight (10-35 pounds), one-man operation, and easy hideaway—make it very difficult to defense.

The Federal Aviation Administration (FAA), USA, made an analysis in the aftermath of 9-11 terrorists attacks which pointed out that though U.S. commercial aircraft have never been attacked by shoulder-launched missiles, there have been 35 commercial aircraft attacked in other regions of the world since 1970, and 24 of them were crashed and more than 500 people killed. Therefore, the U.S. should take prevention measures at any cost to actively research and develop efficient anti-missiles defense systems for commercial airliners.

Israel is also one of the countries facing terrorism threats. In November 2002, an Israeli Boeing 757 commercial passenger airplane was attacked by two SA-7 shoulder-launched missiles fired by al-Qaeda terrorism organization. Fortunately, all of the 250 passengers onboard were safe as the aircraft successfully made a force landing. Israel has even since started its anti-missile system research and production programs.

## Research and Development of Anti-missile Systems

In general, the guidance systems of a missile fall into three classes: (1) infrared homing seeker; (2) semi-active radar guidance seeker; and (3) active radar homing seeker known as 'fire-and-forget'. When an attacking missile is detected, the countermeasures that an aircraft can take include: first, deploying flares to misguide the missiles equipped with infrared homing seeker; second, applying chaffs to interfere the attacking missiles equipped with semi-active radar and active radar homing seeker. When taking these countermeasures during flight, the aircraft is supposed to launch both decoys because the detecting radar can't distinguish the categories of attacking missiles. The third countermeasure action would be primitive, using pilots' visual capability to evade the threats by making a sharp move and changing flight path.

With regard to anti-missile systems for commercial jet airliners, the related technology is not a problem, because the military aircraft's anti-missile systems have been well full-fledged and employed for many years. Unlike commercial airliners which would only face surface-to-air missile threats when flying in low altitude, the military aircraft has to take into account the long range and high altitude threats posed by surface-to-air missiles as well as the threats from air-to-air missiles. The only restriction to the commercial airliners is that they are not able to take an abrupt move to change their flight path.

An observation of the research and development of U.S. and Israel anti-missile systems will be helpful to know further how the military technologies are employed on commercial airliners. The common features of both countries' anti-missile systems are adopting automatic detection, and emitting laser beam or launching flares. The pilots have no need to operate systems and exercise any evading move. In short, the pilots need not to receive any training at all as long as the anti-missile systems are installed on the commercial airliners.

## Flight Guard System Tests

Israel's anti-terrorism strategy has been most aggressive, as the fact that it develops the Flight Guard system entirely on its own manifests. The Flight Guard system installed on the aircraft can detect an incoming missile equipped with infrared homing seeker and automatically launch flares to misguide the missile and fail its attacking.

Israel Airlines successfully installed Flight Guard anti-missile systems on its passenger jet airliners on 15 February 2006, becoming the first commercial airliners of the world to install anti-missile systems, to prevent increasing threats of terrorism activities against Israel commercial airliners.

Currently, five systems have been installed on Israel commercial airliners for testing. If the testing ends up with success, 29 airliners more will install such systems. Estimatedly, each system will cost about US\$1 million.

## Guardian System Testing

The U.S. Department of Homeland Security appropriated US\$45 million to Northrop Grumman Corporation in 2004 to research and modify military anti-missile systems for use on commercial airliners. The detector of this anti-missile system, named Guardian, is located at the end of fuselage belly. When an attacking missile is detected, the aircraft will emit laser beams to confuse the infrared homing seeker of the missile, hence avert a threat.

The testing of guardian systems started first in 2005 on a grounded Boeing 767 passenger airliner of American Airlines to conduct wiring installation tests, and on two commercial airplanes, one passenger airliner of Northwest Airlines and one cargo plane of Federal Express, to conduct flight tests.

A Federal Express cargo plane MD-10 completed Guardian anti-missile system for the first time at Los Angeles International Airport on 16 January 2007; this is the beginning of a series of tests. There will be nine Federal Express cargo planes to conduct flight tests by

March 2008. If all tests are qualified, the costs of each laser anti-missile system are estimated to be US\$1 million. The total purchase costs will amount up to US\$ 7 billion when considering the total number of 6,800 commercial aircraft of USA.

## The Predicaments Commercial Airliners Face in Anti-missile Measures

Though Israel has reiterated the reliability of Guardian system, releasing flares in low altitude can be hazardous to facilities adjacent to airfield, especially the large fuel tanks, refueling vehicle, and the airplanes on ground, if the flares have not burnt out to ashes before they fall to ground. Therefore, the European Union has not approved the commercial airliners equipped with Flight Guard system to land on its airfields.

In USA, though it encourages the research and development of anti-missile systems for commercial airliners, the Bush Administration is doubted about the

laser beams and flares as they can only counter SA-7 Grail missile equipped with infrared homing seeker, but not missiles with radar guidance seeker, such as Stinger. Therefore, establishing airfield area anti-missile defense is currently considered as an alternative.

The threats from shoulder-launched missiles have increasingly become an uneasiness in civil aviation business, but an all-out installation of anti-missile systems on commercial airliners may take several years. Furthermore, in view of current research and development of anti-missile systems, the reliability of installing military anti-missile system directly on commercial jet airliners remains to be verified. However, it is not a problem in terms of technology, but the purchase costs itself is an immense burden while the follow-on maintenance costs is to be included additionally. In conclusion, the predicaments the commercial airliners are facing in countering missile threats need to be solved one by one. ✈

