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MANPADS – DO THEY PRESENT REAL THREAT?

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Abstract: *It is nothing new that shoulder-fired missiles present a persistent threat to military aircraft. But whether or not we also need to protect the commercial airplanes against this kind of menace remains the issue of many debates among aviation experts worldwide. This paper gives a brief overview of history, types and proliferation of these weapons and focuses on possible protection and countermeasures against this threat.*

Keywords: *MANPADS, Threat, Attack, Missile, Countermeasure*

1. INTRODUCTION

Although use of less sophisticated standoff weapons, such as unguided rocket propelled grenades (RPGs) and large-caliber munitions, are also considered as a threat to civil airliners, shoulder-fired missiles are widely regarded as the most capable weapons in terrorist hands for downing a commercial airliner.

While aircraft shootings have historically been documented in the third world countries and war-torn regions, there is growing concern among some aviation security and counterterrorism experts who think that there is an emerging worldwide threat to civil aircraft from shoulder-fired weapons and perhaps other standoff weapons. While this terrorist threat in the current context of the global war on terrorism is considered greatest in regions such as in the Middle East, in the horn of Africa, in other areas of Africa plagued by political unrest, in Afghanistan and Pakistan, and in regions of southeast Asia, the potential for shoulder-fired missile attacks or attacks using other standoff weapons against civilian airliners in Northern America and Europe is likely increasing and cannot be disregarded.[3] Reason is simple. In the post 9/11 era, improved security measures at „western airports“ could logically lead terrorists to commit attacks targeting the aircraft out of secured airport perimeter.

Estimates vary, but the most widely reported statistics on civilian aircraft experience with MANPADS indicate that, over the past three decades, 36 aircraft have come under attack from these weapons. Of those 36, 24 aircraft were shot down resulting in more than 500 deaths.[9] More detailed analyses concluded that only about a dozen civil-registered airplanes have been shot down during this time period and further notes that some of these aircraft were operating as military transports when they were shot down. On the contrary, available statistics may underestimate the total number of civilian encounters with shoulder-fired missiles because some aircraft shootings may have been attributed to other causes for various reasons and are not included in these statistics.

Also, it is possible that some failed attempts to shoot down civilian airliners have either gone undetected or unreported. For many incidents considered to be shoulder-fired missile attacks against civilian aircraft, there is insufficient information to make a conclusive determination if the aircraft, in fact, came under fire. In some instances, while it is widely acknowledged that the incident was a shooting, there has been no conclusive determination regarding the weapon used. For example, in some instances of aircraft shootings there are discrepancies among accounts of the event, with some reports indicating that the aircraft was brought down by a shoulder-fired missile and others claiming that antiaircraft artillery was used. Also, in many instances, there are questions as to whether the flight operation was strictly for a civilian use or may have been for military or dual use (civilian/military) purposes. Therefore, there is no universal agreement as to which incidents should be included in the tally of civilian aviation encounters with shoulder-fired missiles.

2. HISTORY & PROLIFERATION

First use of MANPADS is dated back to Vietnam era by both sides in the war, to provide military ground force protection from aircraft attacks. Historically, these weapons have been used succesfully by militaries, insurgents and terrorist groups around the world. They proved its lethality in number of conflicts over the past forty years.

At present, MANPADS are are believed to be widely available to terrorist groups throughout the world at relatively low cost through a variety of sources. They are regarded by weapons experts as formidable weapons, particularly against transport aircraft and helicopters.[3]

Over the years, twenty countries have been engaged in development or production of the MANPADS. There have been at least 30 different types manufactured, with a total production of more than a million missiles. The majority of MANPADS are either located within military arsenals; have been expended in live-fire exercises, wars, insurgencies, or other conflicts; or have been destroyed, according to State Department officials. Estimates of the global inventory of MANPADS range from 500,000 to 750,000 weapons, with approximately 1 percent outside the control of national governments, according to intelligence sources. In addition, according to the State Department, the numbers of MANPADS in the global inventory are difficult to estimate because destruction of MANPADS systems is not always publicized and the systems' effective lifetimes depend on how they are stored and maintained.[5]

3. TYPES OF GUIDANCE

Based on their method for detecting and engaging targets, MANPADS are primarily classified into three general categories.

3.1. IR guidance. IR-guided MANPADS have sensor or seeker elements that sense and track energy in specific portions of the IR spectral band emitted by target aircraft. IR guidance systems are designed to home in on a heat source on an aircraft, and the missile is typically detonated in or near the heat source to disable the aircraft, typically by impact detonator fuses. For aircraft, the predominant IR energy source is the hot jet engine and its trailing exhaust plume. However, radiant heat reflected off the aircraft's skin also generates a smaller amount of IR energy that can be detected by these weapon guidance systems, particularly among more recently introduced MANPADS. IR-guided MANPADS employ passive weapon guidance systems, meaning that they do not emit any signals to detect a heat source. This makes them more difficult to detect by targeted aircraft employing missile warning and missile countermeasure systems.[4] According to evolution of their capabilities, these types of MANPADS are generally divided into three (sometimes four) categories, or generations.

The first MANPADS deployed during the sixties (Russian Strela-2 or U.S. Redeye) of the last century used earliest homing systems capable only to guide the missile from rear side of the airplane, because their seekers can only effectively acquire and engage target after it has passed the missile's launch position.

Second generation (Russian Strela-3 and IGLA, U.S. Stinger) use improved coolants reducing the temperature of the seeker and enabling the seeker to filter out most interfering background IR sources which greatly improves the accuracy of the missile.

Lower seeker`s temperature is also giving these weapons all-aspect capability (head-on and side engagement profiles), thus, to effectively fire on target from any angle or aspect. Some of these systems also carry backup target detection modes such as the ultraviolet (UV) mode found on the Stinger special variant.

More advanced third generation of IR-guided MANPADS (Russian IGLA-S and U.S. Stinger RMP), use single or multiple detectors to produce a multiband IR image of the target and also have the advanced capability to recognize and reject flares dispensed from targeted aircraft. Current MANPADS`s development is focusing on higher accuracy, greater range and especially on improved guidance systems resistant to IR-countermeasures. The latest guidance systems are utilizing cross-shaped targeting array or a full two-dimensional focal plane array. These systems are sometimes reffered to as fourth generation IR-guided systems.

3.2. Command Line-Of-Sight (CLOS). CLOS missiles do not home in on a particular aspect (heat source or radio or radar transmissions) of the targeted aircraft. Instead, the missile operator or gunner visually acquires the target using a magnified optical sight and then uses radio controls to "fly" the missile into the aircraft. One of the benefits of such a missile is that it is not as susceptible to standard aircraft mounted countermeasure systems which are designed primarily to defeat IR missiles. The major drawback of CLOS missiles is that they require highly trained and skilled operators.[1]

Numerous reports from the Soviet-Afghan War in the 1980s cite Afghan mujahedin as being disappointed with the British-supplied Blowpipe CLOS missile because it was too difficult to learn to use and highly inaccurate, particularly when employed against fast moving jet aircraft.[6]

According to these considerations, many experts agree that CLOS missiles are not best suited for terrorist compared to IR-guided missiles, which are sometimes referred to a "fire and forget" category of missiles. Latest versions of CLOS guided missiles use a solid state camera instead of the optical tracker to make the gunner`s aiming easier (British Javelin) and laser data link instead of earlier radio guidance (British Starburst).

3.3. Laser beam. Laser beam riding shoulder-fired SAMs use lasers to guide the missiles to the target. The missile literally flies along the laser beam and strikes the aircraft where the missile operator or gunner aims the laser. These beam riding missiles are resistant to current countermeasure systems on military and civilian aircraft. Missiles such as Sweden's RBS-70 and Britain's Starstreak, can engage aircraft from all angles and only require the operator to continuously track the target using a joystick to keep the laser aim point on the target. Because there are no data links from the ground to the missile, the missile can not be effectively jammed after it is launched. Future beam riding SAMs may require the operator to designate the target only once and not manually keep a continuous laser aimpoint on the aircraft. Even though beam riders require relatively extensive training and skill to operate, many experts consider these missiles particularly menacing in the hands of terrorists due to the missiles' resistance to most conventional countermeasures in use today.[1]

4. POSSIBLE CONSEQUENCES

It is estimated that thousands of MANPADS even under government controls may be vulnerable to theft and possible transfer to terrorist groups because they are not subject to stringent national export standards nor do they have adequate physical security or inventory controls. Moreover, their lethality, portability, ease of use and concealment, and relatively low cost (from less than $1,000 to $100,000 each) make them attractive to terrorists for acquisition and use against commercial aircraft.

Threats to commercial aviation are numerous and varied, and the cost of instituting preventive measures for all of these threats could become quite large. A sense of the economic impact of an attack affords some context for the allocation of resources to countermeasures. Economic losses may be divided into three categories: immediate, tangible losses from the attack; losses to travelers and airlines during a subsequent air-travel shutdown (as after the 9/11 attacks); and losses to travelers and airlines from reduced demand once the industry resumes operations. Losses during a shutdown and following resumption of service are likely to be strongly conditioned by the success of law enforcement at apprehending MANPADS operators and their supporters. If arrests are made, federal officials can credibly assure the public that air travel is safe, and no further attacks follow the resumption of service, economic losses may be no greater than those shown here for a shutdown that might be as short as a week. If one or more of those conditions is not met, a longer or repeated shutdown and disproportionately larger post-resumption losses may accrue.[2]

Comparing many sources, it has been estimated that the direct economic cost of a catastrophic loss of an airplane from a MANPADS strike or an attack using some other standoff weapon would range somewhere from about $500 million to $1 billion per aircraft, depending on the size of aircraft and the number of passengers lost in such an attack. Beyond these direct costs associated with the actual destruction of property and loss of life, an attack could have a considerable impact on the airline industry and the broader economy. However, the scope and duration of such an impact is difficult to predict, and it is extremely difficult to provide a monetary estimate of the economic impact from such an attack. Possible responses to an aircraft shooting could be cancellation of certain flights, shut down certain airports, or shut down of the whole air traffic in entire region.

5. ACTIVE COUNTERMEASURES & PILOT TECHNIQUES MITIGATING RISK OF ATTACK

There are generally recognised three types of countermeasures (currently applied or under development) – flares, laser jammers and high-energy lasers. Flares may be released either preemptively (before the onset of an attack) or reactively, after an IR surface-to-air missile (SAM) launch is detected. In the case of terrorist attack, which is difficult to predict, and so for commercial applications, reactive flares are the practical consideration. While military transport aircraft employ a variety of countermeasures to mitigate the threat posed by IR-guided missiles, including smaller shoulder-fired missiles, the use of IR-countermeasures on commercial aircraft has been quite limited, and generally speaking, commercial passenger airliners are not equipped with such systems. A notable exception is in Israel, where a number of El Al aircraft were initially equipped with deployable flares in 2004, but are now being fitted with laserbased IR countermeasure systems.[7]

However, flares have generally been regarded as being too hazardous for airline operations and airport ground installations, and initiatives have focused instead on exploring the feasibility of adapting military laser-based IR countermeasures for use on commercial airliners. Proposals to deploy various aircraft-based countermeasures on civilian airliners, however, have raised considerable policy debate across the world regarding the effectiveness of such an approach, the cost deploying and sustaining such systems, their potential impact on flight safety, possible environmental constraints on their use, and the fear that their deployment may promote perceptions that flying is not safe.

There exists also a variety of transmitters known as IR countermeasures (IRCMs) generating IR energy fields designated to fool SAMs. IRCMs, compared to flares, do not pose a fire hazard to combustible on the ground, but are similarly effective against IR-guided missiles.

Recent development in lasers have led to employment of directed infrared countermeasures (DIRCMs) which focus their entire energy on incoming missile. They are able to generate more jamming power than IRCMs and offer the most effective defense against modern MANPADS. On the othe hand, their weight, size, cost and reliability, however, may not yet make them suitable for common commercial use.

Some aircraft survivability experts believe that isolating critical systems, like redundant hydraulic lines and flight control linkages, and improving fire suppression and containment capabilities could prevent catastrophic failures cascading from the initial missile strike.[10]

Another potential mitigation technique is training flight crews in evasive maneuvers if fired upon by a shoulder-fired SAM. However, without a missile detection and warning system, it is unlikely that a flight crew would have any indication of a missile launch. Also, large transport category airplanes are generally not maneuverable enough to evade a shoulder-fired missiles. There is also concern that defensive maneuvering of large transport category airplanes could result in a loss of control or structural failure. On the other hand, specific simulator exercises using missile attack scenarios may be beneficial by preparing pilots to fly and land a damaged aircraft. Modern airliners are built with redundancy in avionics and flight control systems, and consequently, a missile strike that does not cause a catastrophic structural failure would likely be survivable if the flight crew is properly trained to handle such a scenario.[1]

Other possible passive countermeasures are a paint designed to mitigate an aircraft`s IR reflectivity and visual profile, and suppressing or mitigating the engine`s hot exhaust. Shielding or ducting an engine exhaust, or mixing ambient air with hot jet exhaust can reduce IR signature of an aircraft by 80% so it would be more difficult for terrorists to employ most types of shoulder-fired missiles. Unfortunatelly, implementation of thesemeasures into existing aircraft can unfavorably affect aircraft`s weight, balance and engine performance.

6. FUTURE OPTION

Unmanned Aerial Systems (UASs) or drones, are sophisticated pilotless aircraft that serve as the eyes and ears for our troops on the ground. These vehicles routinely embark on risky reconnaissance missions that were previously performed by pilots. UASs evolved tremendously over the years and are now an essential part of our mission, especially in remote locations where rough terrain makes things difficult.

Originally, their main purpose was to reduce the need to send pilots to risky and dangerous missions and areas. In a modern warfare, they are becoming irreplaceable. But thanks to its valuable advantages like long endurance, flexible usage and high cost-efectiveness ratio, they are now in the scope of multiple non-military sectors.

Some studies were evaluating the feasibility of equipping UASs with surveillance sensors and with weapons capable defeat heat-seeking missiles fired from ground. Project CHLOE, research and development program of the Department of Homeland Security (DHS), objective was to assess the feasibility of persistent high-altitude standoff counter-MANPADS protection of commercial aircraft and to evaluate attendant concept of operations and life cycle costs. A supporting objective was to investigate and demonstrate the feasibility of one or more UAS with Missile Warning Systems (MWS) and countermeasures stationed near airports to provide autonomous coverage for all aircraft within the MANPADS threat envelope. Secondary objectives were to investigate and demonstrate other DHS missions and payloads compatible with the CHLOE platform and operating environment, and interface with air traffic control and law enforcement for situational awareness. However, the system concepts evaluated in the CHLOE program are not conducted by follow-on development so far.[11]

7. CONCLUSION

Combating air terrorism requires the use of a wide range of organizational and technical efforts based on appropriate legislative solutions. While terrorist actions are very hard to predict, nevertheless there have been put in place universal international legal measures that are designed to help protect aviation from illegal interference. The organizational activities dealing with aviation security should also embrace prevention against terrorist assaults.

The technical elements of safety system infrastructure have to allow for the monitoring of the overall situation on an entire airfield. Such a comprehensive, integrated approach to aviation security will help to forecast the risk of terrorist attacks, and provides the best chance to adequately protect aircraft, both on the ground and in the air.

Finally, it is critical to have in place a set of clear and robust plans in order to respond to crisis situations in the air and on the ground, which must be supplemented by relevant training to learn the proper procedures for any counter-terrorist action.

However, in policy debate, it is important to note that the various countermeasures under consideration for mitigating the MANPADS threat are not designed to be effective against all types of MANPADS and are not considered to be capable of thwarting attacks using either laser beam rider or CLOS MANPADS.[3]

While the threat posed by MANPADS is really high, it represents a predicament for policymakers for several reasons.

1. Although it is well known that terrorists possess these weapons, attacks using them have been relatively rare.

2. Although probability of an attack is quite small in number, airliners remain vulnerable against this threat, because during takeoff and approach to landing they fly at low altitudes within effective range of these weapons. Civilian aircraft, unlike the military ones, carry no special countermeasures and are not agile enough to evade a missile attack. On the other hand, the odds of a large commercial plane surviving a hit from MANPADS are fairly high thanks to numerous redundant systems on board allowing the planes execute an emergency landing after an attack.

3. Even if an aircraft survive such an attack, it would be enormously difficult to restore confidence in air transport among the travelling community. Worse, a succesfull attack would have devastating and long-lasting consequences not only for entire airline industry (comparable with the 9/11 attacks), but also for whole economy.

But the decision whether or not to install additional ground and on-board countermeasures against the MANPADS due to high costs and uncertain effectiveness in protection the airliners will not be solved in near future. For example, options mentioned in this paper (or combination of them) can reduce aircraft`s vulnerability to weapons threat to some degree, but they cannot completely eliminate the threat. Probably implementation of UASs should be the right, effective and relatively cheap solution for surveillance and protection of the airport area including the adjacent departure and arrival routes.

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