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Least Risk Bomb Location Explosives Identification, Detection and Mitigation

Neha Bhatia[1]

[1] Galgotias University

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Abstract

This paper investigates the still evolving strategic trajectories and the context adopted for the procedures for inducting a Least Risk Bomb Location (LRBL) that began with discretionary participation by various aircraft manufacturers approximately in the year 1972, where the use of a specific procedure has been designed to decrease the effects of an explosion significantly in the aircraft?s passenger cabins of large commercial airplanes. Additionally, the International Civil Aviation Organization (ICAO) has provided the information on the location of the LRBL and guidance to various operators (National/International) on the procedures to use when a suspected threat item is found on-board an airplane. The designation of LRBL for aero planes is intended to be used solely for the transport of cargo, where an aero plane must include a designated location where a bomb or other explosive device could be designated to protect integrity of the structure and flight-critical systems from damage in the case of detonation occurs.

Index terms— aviation study, flight-critical structures, , damage on detonation.

1 Introduction

his paper aims to explore and assess the still emerging strategic trajectories of the airport security means and the mitigation of the threat caused due to a suspected bomb on-board which can be is effectively reduced. Supposedly, if a cabin crew or a ground staff of an operator receives a bomb threat, or finds a suspicious package on-board, what shall be the procedure as per various operators around the globe to follow, is apparently the works to articulate and implement the path forward by each operator to reduce the damage to an aircraft to best protect the integrity of the aircraft's structure.

We all have probably heard the Shoe Bomber attempt from the year 2001, which was thwarted by some brave passengers and crew, and also the fact the bomber had sweaty feet where his swamp foot dampened the trigger preventing it from igniting.

Similarly, In the year 2016, an aircraft made an emergency at HCMM/Mogadishu airport after a bomb exploded on-board. Another incident, where the bomb was likely brought on-board concealed within a laptop, in which the flight was lucky though because the impact of the bomb was minimal, limited because the bomb exploded while the aircraft was at a lower altitude **??**11,000ft). In the year 2020, a European airline found a 'bomb note' on-board, which was escorted to a safe landing and passengers disembarked without incident.

We do anticipate about potential bomb threats, and attempted bombings, do occur, and while security is getting better and better, unfortunately terrorists are getting more creative in finding ways to bring dangerous suspected devices on board. The attempts are not always aimed at causing destruction either, though threats alone cause a huge amount of disruption to operations. So understanding how to assess the risk and credibility of a threat is as important as knowing how to deal with a possible explosive device if one is found on-board.

2 II.

3 Literature Review

On being told or somehow finding out that the aircraft on which you are flying has a bomb on board, or even finding such a device unannounced and unsure, must be one of the most feared experiences in the world of flying even today. As humans our mind instantly focuses on the horrors of the Air India flight over the Atlantic in 1985 and Pan Am flight 103 over Lockerbie in 1988, before going numb. These horrors are all too apparent, but preparation in the event of such an occurrence can help increase the chances of a successful outcome and the survival of all the souls on board. Bomb threats received by airlines, of which there are many, are normally handled at the airline's base by a team devoted to such work and the decision is made there as to whether the threat is a serious one or just a hoax. If, as fortunately rarely happens, the threat is considered to be real, the first procedure is to contact the Captain of the aircraft and inform him of the situation. The procedures in a serious bomb threat situation vary according to the location of the aircraft and if the aircraft is on the ground, a controlled evacuation should take place. The bomb disposal teams also play a very essential role in such a situation, as they are supposed to start at one end of the aircraft and work through everything in their search until they find the offending device.

Data on emerging air markets and risks involved are extremely challenging, and what are available must be carefully considered in terms of accuracy and veracity. Following simple precautions, and every airline having its own detailed procedures of what to do in case of a bomb threat may not lessen the trauma of being on an aircraft with a bomb on board but warning of the device gives crew members the greatest chance of preventing a disaster that can endanger the safety of the aircraft and the lives of all on board.

A literature forage was conducted to recognize that every threats must be assessed to determine its significance and the risk associated to adopt appropriate measures to be implemented to eliminate the cause of nuisance that is intended by any potential suspected device found on-board an aircraft or in airport facilities. The search yielded three major categories of relevant past efforts, firstly, the characteristics of Bomb threats with large number of efforts involving the simulation analysis of disaster management. Secondly, a variety of contingency plan related research efforts directed at improving emergency response efforts for an assessment of the warning and the risk involved, by designated and accredited personnel (Bomb Threat Assessors / PNP AVSEGROUP Special Operations Unit) employing Positive Target Identification (PTI). Thirdly, relevant research efforts include a series of assessment of the risk posed by a bomb warning on the Ground as well as in the Air. These include bomb threat action in consultation with the police and other appropriate agencies, each aircraft operator, airport and cargo agent should develop contingency plans to be implemented when bomb warnings issued against it are assessed as RED or AMBER to reduce the risks arising from such bomb warnings.

4 III. Aircraft's Design Considerations & Harmonization

A key theme that has emerged in this study's data concerning the Code of Federal Regulations (CFR), part 25, § 25.795(c), "Least risk bomb location." With regards to the aircraft's design considerations researchers have assessed that because the voluntary approach has identified the LRBL after the basic design of the aircraft was complete, it did not provide the safety improvements that are possible when the LRBL is included in the initial design process therefore, additional features may need to be explored to improve safety. Design considerations may include speciallysized areas or pressure relief panels in the cabin structure where a suspect device should be placed by the operating crewmembers. On airplanes with more than one passenger deck, more than one LRBL may be desirable which provided a related Advisory Circular harmonizing with the European Joint Aviation Authorities (JAA). That draft provided a method of compliance that both the FAA and JAA found acceptable and subsequently, the European Aviation Safety Agency (EASA) was formed as the principal aviation regulatory agency in Europe, resulting the FAA working with EASA to ensure that the proposed Advisory Circular is harmonized with the draft referred to in EASA's Certification Specifications.

The sub-theme of aviation security invariably linked to issues and controversies surrounding the fear of bomb threat within air fliers subsequently enacting the government to constitute a regulation for airlines, and notions of what to provide in guidance for LRBL design as well as establish critical parameters that need to be addressed to demonstrate compliance with the requirements of Title 14, Code of Federal Regulations (CFR), part 25. The accurate design of constructing an LRBL includes the amplifying effects of the differential pressure between the cabin and the outside air, which can be significant. The perfect structure of LRBL sustains the maximum damage when an explosion occurs in a fully pressurized airplane.

When a suspected item is found in the cabin of an airplane in air, measures to minimize its effect should include few procedures. Firstly, reducing the aircraft's cabin pressure, with full depressurization and to reduce the damage caused by an explosion; secondly, minimizing the loss of integrity of the structure or systems; thirdly, using explosive containment devices; and, lastly, conducting operational procedures established in consideration of the airplane performance.

While it is important that the crew should be aware of the LRBL, the LRBL should not be marked or otherwise obvious to other persons. Close coordination among the airframe manufacturer, operator, and regulatory authorities is needed in order to maximize the effectiveness of the LRBL and associated procedures.

5 IV. Demonstration of Compliance for Aircraft Manufacturers and Airline Operators

When determining the preparation of LRBL, there are few operational and design issues that should be addressed, like If the applicant chooses a site adjacent to the fuselage skin, the applicant should assume that a portion of the structure will be lost. The applicant should determine the structural capability of the airplane in the presence of the resulting opening. For example, if the LRBL is a door, it should be assumed that the entire door is lost. If the area is not a door, the following factors should be considered: a) When using this approach, the LRBL fuselage-skin blowout area must be discontinuous from the surrounding structure, so that cracks developed in the blowout section cannot propagate into the surrounding structure. b) The dimensions of the LRBL blowout region should be no smaller than a 30-inch diameter circle. However, the dimensions may be reduced to no less than a 20-inch diameter circle, if the basic airplane geometry and other considerations prevent a larger diameter. c) Adequate space must be available to place the attenuating materials required by the operational procedures. d) The LRBL should allow the suspect item to be placed as close to the fuselage skin as possible.

That is, interior features, such as galleys, closets, and seats, should not obstruct access to the LRBL or the space available for the LRBL.

The location of the LRBL should include considerations of the secondary effects, including the aircraft structural losses, ingestion of debris into the engine, large mass strikes on the tail plane, smoke or fire, and the hazards to passengers. The applicant should also evaluate system integrity in the area likely to be affected around the LRBL. Wherever practicable, flight critical systems (including fuel systems) should be kept 18 inches away from the established LRBL contours, as shown in Figure below. In addition, flight critical systems should be kept out of the area under the floor at the LRBL for a distance of 30 inches inboard over the width of the LRBL cut out, also shown in Figure **??**elow. This applies to systems that are attached to the floor beams or mounted above the bottom of the floor beams.

As we can see in the figure above, here in this case, the applicant should consider adding protection from fragments and large structural deformation to systems that must be run in proximity to the LRBL. Systems shielding and/or inherent protection should be able to withstand fragment impacts from 0.5-inch diameter 2024-T3 aluminium spheres traveling 430 feet per second. The ballistic resistance of 0.09-inch thick 2024-T3 aluminium offers an equivalent level of protection. System designs must incorporate features that minimize the risk of their failure due to large displacements of the structure to which they are attached. This may include flexibility in both the systems and/or their mountings. In the absence of test evidence or alleviating rationale, provisions should allow for a minimum 6-inch displacement in any direction from a single point force applied anywhere within the protected region. The applicant may also incorporate frangible attachments or other features that would preclude system failure. During early years of aviation threats, the LRBL was chosen where there was intrinsic structural reinforcement, however, the applicant may take other measures to meet the intent of the rule. An example would be a containment system. Such an approach would require the concurrence of the applicable Aircraft Certification Office and the Transport Airplane Directorate to establish the appropriate criteria. In most circumstances, it is preferable to reduce the cabin pressure differential to zero. Reduction of cabin pressure is an extremely effective way to minimize structural damage in the event of a detonation. The goal of LRBL procedures is to mitigate the effects of an inflight explosion and to enhance aircraft survivability through use of prior planning, training, and available resources.

After all the substantial data gathered it is evaluated that threats received regarding an aircraft need to be assessed, and the credibility needs to be determined. The threat classification will generally be based around how specific the threat is, depending on which most of the airline operators will have a procedure in place for determining this, and probably take into account about the following: Once talking about the term Red Threat, it often refers to a threat that mentions a specific target, or is made by a known terrorist organization and is deemed credible then this is going to be considered more serious, whereas, a threat which is vague, general, and doesn't specify targets might be considered less credible in comparison. A hand scribbled note in the toilet for example, would be categorized as a green threat.

Considering a bomb threat to be genuine or hoax in nature, irrespective of the assessed credibility, a bomb threat has to be taken seriously and treated as a genuine situation.

intermediaries (e.g. the media, press agencies etc.). In either case, recipients should endeavour to obtain as much information as possible about the warning in order to facilitate assessment of it and identification of the person issuing it. Staff who are likely to receive bomb warning calls, telephonists and sales staff, should be briefed on the subject on taking up their duties, and the responses required from them should be incorporated into appropriate staff instructions. Every staff involved in such work areas should be provided with checklists to facilitate their reactions. Supervisors should be similarly aware of the response required and of the need to relay information about bomb warnings to Bomb Assessors. Any staff receiving warnings directly should listen carefully and make a note of the actual words used by the caller, take action to trace the call or alert a colleague in order that they may do so; take such action as may be necessary to tape record the call, where this is not done automatically; try to prolong the call to obtain as much information as possible; and lastly try to ask the caller:

? WHERE is the bomb? ? WHEN will it go off?

? WHAT does it look like?

? WHY are you doing this?

? WHO are you?

If possible, the recipient should test the credibility of the caller by making up a non-existent flight number, flight time or location and asking the caller whether that is the one to which he or she is referring and then immediately inform a supervisor who will, in turn, inform the Bomb Threat Assessor / AVSEGROUP SOU; the police; and the Administrator OTS.

People receiving calls from intermediaries should ask for, and make written note of, the precise time at which the warning was issued and the exact words used by the caller; and simultaneously ask whether the intermediary obtained answers to any of the questions detailed above, and about the origin of the call and the caller's identity, using the headings on the reverse of the Bomb Warning Report Form. The recipient of a written bomb warning should preserve the message and deliver it to the supervisor with precise information about its discovery. Messages discovered in flight should be referred to the aircraft captain immediately, whereas, the supervisors should interview the recipient of any call or message in order to complete the Bomb Warning Report Form, and relay it without delay to the Bomb Warning Assessor.

6 a) If aircraft is on ground

One of the safest option for every operator and cabin crew on the ground, is to disembark and carry out a full search of the aircraft. Although the process might be very tedious and may cause operational delays, but the possible alternative may be much worse. A serious threat may require a precautionary deplaning of the onboard passengers which will result in offloading the passengers as quickly and as safely as possible. The situation here creates a remarkable risk to safety of all the souls onboard in itself and also the credibility of the threat will be communicated to the cabin crew so that they can judge the risk of waiting for the regular step ladders to arrive or to immediately evacuate passengers to clear the aircraft. There might also be a risk involved in evacuating passengers in the tarmac without having any backup from the airport for passengers as passengers may be hurling around the tarmac.

7 b) If the aircraft is in Air

Imagine a threat is received while an aircraft is in the cruise phase. In such a crisis, the cabin crew are trained to carry out a search, checking all the potential places that are often overlooked during the ground security checks, but where an article might easily be concealed that may be toilets, galleys, jump seats, stowage areas, closets etc. The advised theory here is Least Risk Bomb Location Explosives Identification, Detection and Mitigation found, then cabin crew is trained specifically not move it or touch it, but rather move passengers away from the immediate area, and remove any flammable items and have fire extinguishers readily accessible to fight the fire. Following this an announcement to page for anyone onboard with 'BD or EOD experience' is again being advised by airline operators, as these are the terms that only the concerned will recognize without the normal passengers getting intimidated. Keeping the passengers calm in such a crisis may probably be the best call of the situation, but ensuring that passengers are following the crew's orders, and that they are prepared for the situation on the ground, is also imperative, which means providing them with clear information, but without exaggerating the situation.

8 c) If a suspicious article is found

Almost every aircraft manufacturer provides their approved checklists for bomb-on-board situations, amongst which are a few measures that needs mandatory considerations.

? A continuous communication with ATC is mandatory so that they know exactly what is going on and what is exactly needed. The ATC and the team involved assists with locating an airport with services needed, and coordinates with military if necessary. ? It is advised to avoid routes over heavily populated areas and consider carefully the choice between flying fast to minimize airborne time versus flying slow to minimize air-loads and damage (in the event of fuselage rupture). ? It is also advised to the Pilot to request for a remote parking on the ground if there isn't a designated bomb location.

? Also, a rigorous briefing by pilot to all the operating cabin crew members for a possible emergency landing, and in any event, brief them to ensure passengers are disembarked quickly and moved to at least 200m upwind from the aircraft, needs to be done, as an SOP in case of a bomb threat. ? It is a recommended practice for all the pilots to avoid large and rapid changes to pressure altitude and consider using manual cabin altitude controls to minimize the rapid change of pressure while still lowering the aircraft cabin altitude to minimize the differential pressure.

Aircrafts are designed to not 'explode' if there is a rupture in the fuselage due to which they tend to have a lot of smaller sections attached together, making the overall aircraft structure way more resilient to the effects of an explosive decompression. The idea of reducing the differential pressure to around 1 PSI also reduces the damage if an explosion occurs, whereas, maintaining a slight differential pressure ensures that the blast moves outwards, but the lower differential limits the force of air from the cabin outwards.

Bomb exploded at low altitude so differential pressure was lower VI.

9 Aircraft's LRBL as Certified by Manufacturer

As prescribed by every aircraft manufacturer a Least Risk Bomb Location are often near aft/rear doors or in washroom stowage areas, which provides the least risk, in the event of an explosion, to flight critical structures and systems. If the suspected device is deemed unsafe to move/or turns out to be an anti-lift device, then the cabin crew needs to cover it in plastic to prevent any liquids getting in, and then pile blankets and pillows, seat cushions and soft clothing around it. It is also recommended to build as big a pile as the crew can, and once done, saturate in water to minimize fire risk in case an explosion does occur. Also a thick and prominent layer surfacing of the plastic sheets on top of the suspected device should be placed mandatorily to avoid liquid damage to electrical components. In case of ruling out that the suspected device isn't an anti-lift and the cabin crew can possibly move it to the least risk area, an LRBL should be constructed and the suspected item should be placed as per the guidelines of the operator's manual, and subsequently building up the barricade.

It is always suggested to minimize movement to any article as much as possible, and restrict putting anything directly on top of it. An igloo of saturated cushions around it and the gaps stuffed with blankets and clothes is a standard recommendation for LRBL. This 'cushioning' helps to minimize the force if an explosion does occur.

At any instance a cabin crew happens to discover a suspected Improvised explosive device (IED) in an aircraft, it is recommended by the manufacturers as well as the airline operators in their manuals that the operating pilots must descend and depressurise the aircraft cabin before the suspicious item is physically placed in the LRBL by the cabin crew. Once mentioning the responsibilities of cabin crew members, they intend to have the most critical role of identifying and preparing the LRBL and moving the suspicious device to this specific location. Now, this suspected device should be placed extremely close to the fuselage bearing in mind about the extremities in case of a loss of portion of the aircraft, should the device detonate. Every manufacturer has a manual with the guidelines being specific on the designated location of LRBL which is usually one furthest away from the critical structures; which are the flight deck, fuel tanks and in an area designed to 'open' i.e.; the aircraft door. The on-board duty of a cabin crew in this situation always shall be to move the IED after ruling out the possibility of the device being anti lift, simultaneously escorted by other crewmembers collecting items such as seat covers and suitcases for placement at the LRBL. The built of LRBL base needs to be essentially very strong at the bottom, having built upwards in the shape of a pyramid as thick as possible, with all the possible items that may be collected by cabin crew on-board, requiring suitcases and other heavy materials surrounding it, more of the force from the bomb should be pushed outside causing the shock front travelling better through denser materials. The use of dampened blankets is then placed immediately above the suspected device, and eventually separated from it by a sheet of plastic such that in the event of a blast, the water uses up the heat energy by converting it into steam. The use of softer materials, such as cushions and clothing, are then placed above the blankets, as it is proven to be poor mediums for transmitting shock whilst also diminishing the effect of any fragmentation.

In case the IED does not detonate, upon landing, a trained EOD/BDDS unit shall be called upon to take control of the aircraft where the position of the suspected IED within the stack should be identified by using an item such as a rope or a cable (prior marking done by cabin crew). When on the ground, passengers should be evacuated as safely and as quickly as possible to a safe zone.

10 VII.

11 Conclusion

Crewmembers shall potentially have very minimum chances to experience an IED threat on their aircraft having extremely tight security procedures and technological improvements that precede each flight. Also that most bomb threats are a false alarm which do not involve actual explosives, but only the incitement of fear making the job of cabin crew ready for all eventualities by knowing how to react effectively. If a suspicious device is detected inside the aircraft, the The concept of LRBLs were not considered in the design of most aircraft and there is scope for prospective safety improvements rather than the retrospective considerations currently in place. The incorporation of a bomb containment area or casing and/or pressure relief panels would both reduce the time to effective containment of an IED by crewmembers and reduce the impact of a blast wave causing minimum structural damage to an aircraft and casualties. New containment bags such as a 'Fly Bag', should be tested on passenger flights that can easily be produced in smaller sizes to be discretely stored in an overhead locker in the passenger cabin. Effective simulation and proper crew training and protective measures in both aircraft design and equipment can save precious time and effort when identifying the LRBL and containing a potential blast.

While experiencing the biggest challenge in such a crisis, money and, most importantly, lives will be saved in the event of a catastrophe.

Standard procedure is usually to take all threats seriously because civilians are usually threatened by them if valid as well as the community, and arrests may be made even for bomb threats made falsely as in most jurisdictions even hoaxes are a crime.

Signs that a threat is legitimate include an outof-place object found, a motive or specific targets being stated, and multiple or specific threats are being made. [1]

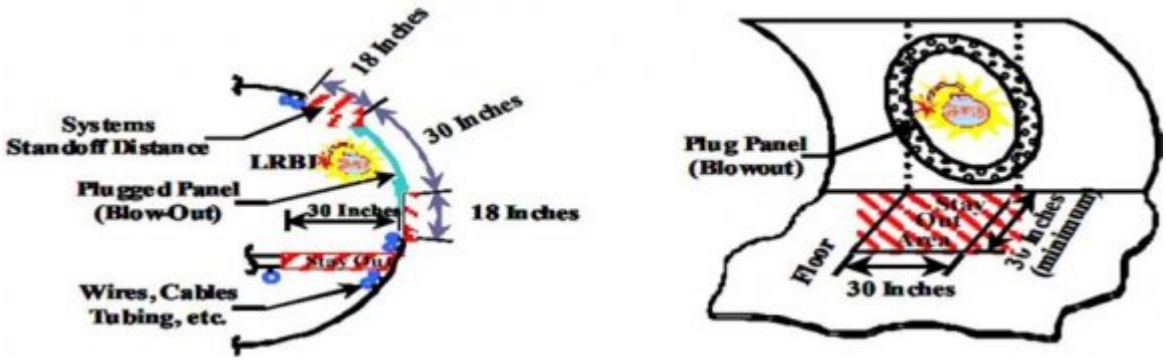

Figure 1:

Figure 2: Global

Figure 3:

Figure 4:

Figure 5:

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