August, 24, 2011

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Airlines' pilots' perceptions concerning recommended practices that reduce the risk of bird strikes

Abstract: There has never been an aircraft accident related to civil aviation in Brazil that claimed a life as a consequence of a bird strike. Airlines have had direct losses of over $6,000,000.00 per year since 2001. Although having just a few crew members injured because of bird strikes, usually pilots, Brazilian airlines and aviation companies cannot afford the risk of an accident and its probable consequences. Bird strike risk management is a defense in depth: airplane certification/construction standards, action by airport operators, procedures by aircrews and standard regulations by ICAO and national regulators. Safety is typically managed from a systemic perspective in which the accident results from a chain of events. Yet, pilots are usually the last domino piece before a mishap occurs, and most of the time they are also the last people who could avoid an accident. But they are also the ones who are always in contact with all sorts of hazards. The purpose of this study is to assess the Brazilian airlines' pilots' knowledge of recommended practices that could reduce the risk of accidents due to bird strikes. The Safety Management Systems (SMS) principles, the pilots' knowledge of bird hazard and safety management systems as well as previous studies by safety professionals will help explain why and how pilots play a big role in managing the risk of bird hazard. The results show that Standard Operating Procedures (SOPs) and safety training comprising recommended practices for pilots can help reduce the risk of bird hazard.

Key words: risk, bird strike, Safety Management Systems (SMS)

1. INTRODUCTION

Lu, Wetmore, and Przetak (2006) cited that the airline industry is extremely safe, but safety professionals must struggle to find ways to keep it even safer. Although aircraft accidents are rare, they may affect the prosperity and security of a nation (Heinrich & Granniss, 1959). Deaths, billions of dollars in losses, and unemployment are some of the consequences that a country faces after a tragedy.

Air traffic has increased substantially in Brazil in the last twenty years. Brazil's airlines have been growing at a rapid pace, air traffic doubled in the last ten years, and the international capacity is expected to grow by 25% in the coming years (Flottau, 2007).

Brazil has the second largest aircraft fleet in the world and the second largest number of catalogued bird species. Its vast territory and ecosystem variety have favored the increase of the tourism industry and consequently the demand for new domestic and international flights. At the same time, due to population growth and especially poor government policies in the past failing to restricting activities close to airports that attract birds, pilots have coping with the risk of bird hazard near airports (Bastos, 2000; Mendonça, 2008).

According to the Aeronautical Accidents Investigation and Prevention Center (CENIPA), in 2010 there were 1,324 bird strikes reported, including military aircrafts. Despite the importance of reporting bird hazard to feed a database that accounts for a scientific basis for identifying risk factors and providing timely and proactive countermeasures to reduce the risk (Lu, Wetmore & Przetak, 2006; Wells & Rodrigues, 2003; Wood, 2003), only 20% of the bird strikes are reported (Bastos, 2000; Dekker & Buurma, 2005; Dolbeer, 2006; Eschenfelder, 2003; Mendonça, 2008).

Effective safety management requires a systemic approach to the development of safety

policies, procedures and practices to allow the organization to achieve its safety objectives. Similar to other management functions, safety management requires planning, organizing, communicating, training and providing direction.

The application of systematic, proactive, and well-defined safety management systems allows an organization to generate a product or service that will achieve a realistic and efficient balance between safety and production. The forecast growth of air transportation in Brazil requires new measures and a greater effort from the aviation industry—including airlines—in order to achieve a continuing improvement in the level of aviation safety.

An array of actions is available to airports operators to reduce the risk of bird strikes. However, there is no training for pilots regarding the reduction of the severity and/or probability of bird strikes. Yet, there is virtually no training for pilots regarding the management of the risk of bird strikes nor is any required by regulators (Eschenfelder, 2005).

Safety training within an organization must ensure that personnel are trained and competent to perform their safety management duties. Safety training for operational personnel should address safety responsibilities, including following all operating and safety procedures (ICAO, 2009).

2. SMS

An SMS can be compared to a toolbox. It is a toolbox that contains the tools that an aviation organization needs in order to be able to control the safety risks of the consequences of the hazards it must face during the delivery of the services for which the organization is in business. In many cases the organization itself generates the hazards during service delivery.

Safety is a concept that must encompass relatives rather than absolutes, whereby safety risks arising from the consequences of hazards in operational contexts must be acceptable in an inherently safe system. As long as safety risks and operational errors are kept under a reasonable degree of control, a system as open and dynamic as the aviation industry is considered to be safe. In other words, safety risks and operational errors that are controlled to a reasonable degree are acceptable in an inherently safe system.

2.1 Risk Management

Vincoli (2006) defines risk as the "likelihood or possibility of hazard consequences in terms of severity and probability" (Vincoli, 2006, p.10). Safety risk is the assessment, expressed in terms of predicted probability and severity, of the consequences of a hazard, taking as reference the worst foreseeable situation. The process of bringing the safety risks of the consequences of hazards under organizational control starts by assessing the probability that the consequences of hazards materialize during operations aimed at delivery of services (ICAO, 2009).

Once the safety risk of an unsafe event or condition has been assessed in terms of probability, the second step in the process of bringing the safety risks of the consequences of hazards under organizational control is the assessment of the severity of the consequences of the hazard if its damaging potential materializes during operations aimed at delivery of services.

According to Lu, Wetmore, and Przetak (2006), if either the probability or severity or both can be minimized, the risk (R) of an accident will also be minimized. Thus, when the reduction of a potential risk (R) becomes urgent, the multiplication of probability (P) by severity (S) (i.e., Risk = Probability x Severity) can be flexibly used to achieve the determined safety goal (Vincoli, 1993).

The ICAO (2005) suggests that the probability of adverse consequences - the rate of exposure to the hazards - increases through increased exposure to the unsafe conditions, therefore exposure may be viewed as another dimension of probability.

Safety risk management is a term that encompasses the assessment and mitigation of the safety risks of the consequences of hazards that threaten the capabilities of an organization, to a level as low as reasonably practicable (ICAO, 2009). Safety risk management is therefore a key component of the safety management process.

According to Reason's theory of organizational accidents (1997), accidents are usually caused by the concurrence of multiple safety factors. Since potential risk exists, reducing risk probability and/or risk severity upstream is essential to preventing accidents.

When the acceptability of the risk has been found to be undesirable or unacceptable, control measures must be introduced. The level of risk can be reduced either by reducing the severity of the potential consequences, or by reducing the likelihood of occurrence (ICAO, 2009).

Safety risk control and mitigation strategies are mostly based on the deployment of additional safety defences or the reinforcement of existing ones. Following ICAO (2009), defences in the aviation system can be grouped under three general categories, being training one of them.

The Flight Safety Foundation (2002) stated that training is of paramount importance to effective job performance. Effective performance means compliance with the requirements of safety, profitability and quality. The objective of all training is to equip employees with the skills, knowledge and motivation to perform their duties safely and effectively (Helmreich & Merrit, 1998; Soeters & Boer, 2000).

Training for pilots may include additional or changed procedures, new supervisory controls, changes to training, additional or modified equipment, or any of a number of other elimination/mitigation alternatives. Safety training within an airline must ensure that personnel are trained and competent to safely perform their duties.

To summarize, an organization manages safety by ensuring, through its safety management process, that the safety risks resulting from hazards in critical activities connected with the provision of services are controlled to a level as low as reasonably practicable (ALARP). Safety risk management is a generic term that encompasses two distinct activities: hazard identification and safety risk assessment and mitigation.

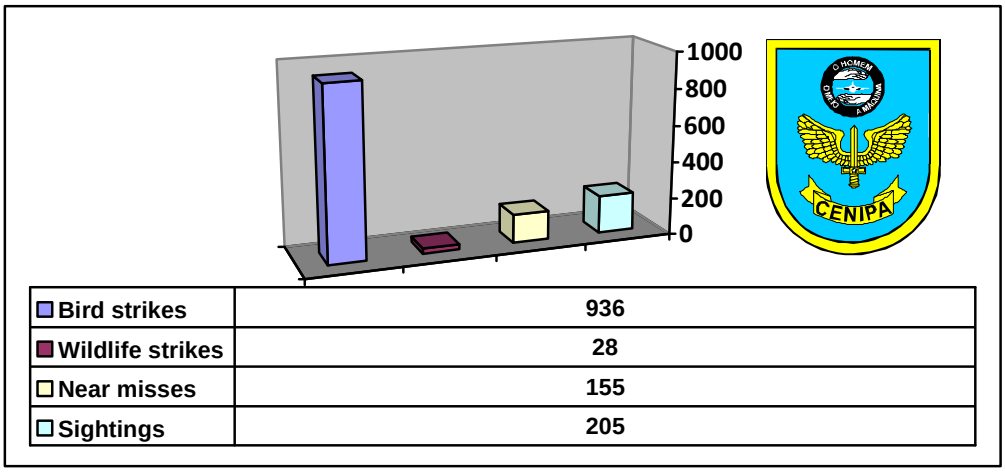
3 BIRD HAZARD

Birds have posed a potential hazard to aircraft since one of the greatest achievements in human history, the first officially observed, self-propelled heavier-than-air craft flight on October 23, 1906, in France, by the Brazilian Alberto Santos-Dumont. What used to be a minor risk to the relatively small amount of early, slow flying aircraft has today become a significant safety concern due to the increased airspeeds and much quieter engines of state-of-the-art airplanes.

Bird strikes are highly expensive to the aviation industry. The associated costs of down-time for inspection and repair following a bird strike, the rescheduling of flights, and passenger accommodation could be, in addition to other direct and indirect costs, significantly damaging to both airlines and public perceptions of the safety and viability of air travel.

3.1 Bird Hazard in Brazil

Collisions between aircraft and birds are a concern in Brazil. Although having just a few crew members mostly pilots injured because of bird strikes, Brazilian airlines and aviation companies cannot afford the risk of an accident and its probable consequences.



Bird strikes	936
Wildlife strikes	28
Near misses	155
Sightings	205

Figure 1. Reported occurrences in 2010 (source CENIPA).

The safety structure in Brazil was established in 1971, with the creation of the Aeronautical Accident Investigation and Prevention System – SIPAER and the Brazilian Aeronautical Accidents Investigation and Prevention Center - CENIPA. Since then more than 6,000 safety specialists have been trained by CENIPA professionals.

Airlines, small aviation companies, aircraft manufacture's, technical centers, airport administrations, military units and commands, air traffic control system, aviation schools and aviation maintenance businesses are connected to CENIPA as parts of this systemic structure (CENIPA, 2008).

In 1991 CENIPA initiated the development of the Brazilian Bird Hazard Control Program. The accidents and incidents related to bird strikes, although already recorded in the database, started to be inserted in a different system following what had been

established by ICAO in its *Manual on the ICAO Bird Strike Information System* (ICAO, 1989). To feed this program, an appropriate and standard form, known as *CENIPA 15,* was developed and disseminated throughout the SIPAER.

The bird hazard database is operated by CENIPA, an organization separated from the Brazilian Civil Aviation Authority (ANAC) responsible for the enforcement of aviation regulations, so any piece of information received by CENIPA is used only for prevention purposes (ICAO, 2005; Reason, 1997; Wood, 2003).

The Brazilian Bird Hazard Committee, which was created in accordance with ICAO recommendations and national regulations, includes Brazilian major airlines, airport managers, airlines' trade union, among other entities. It is, along with the Brazilian Bird Risk Management Program, managed by CENIPA.

Since 2001 CENIPA has supported and promoted national and international seminars to discuss the theme of *Bird Hazard*, to publicize and motivate the use of the CENIPA 15 form and also to foster the development of techniques towards the reduction of the risk of bird strikes.

According to Bastos (2,000), despite having the most diversified bird population regions of the world, with more than 1,700 known species, Brazil has almost no reports of bird strikes due to migratory birds. Yet, because of some specific problems, Brazil's statistics are somewhat alarming, and a well orchestrated Bird Risk Management Program is paramount. Indeed, recommended procedures should be included in this program to be adopted by pilots, in the military and civil aviation environment, that will reduce the risk (probability and/or severity) of bird strikes.

3.2 Reduction of risk by pilots

Bird strikes to aircraft cause thousands of life-threatening incidents and millions of dollars worth of damage to the aviation industry annually. This hazard is largely preventable, according to Rao and Pinos (2003). However, it has not been properly addressed to date for a variety of reasons.

Many airports worldwide have ongoing problems which have not been approached in a proactive manner. Yet, most airlines have not taken steps to prevent accidents and incidents due to bird strikes. Many pilots are not trained on bird-strike avoidance neither is this subject well developed.

Dolbeer (2006) recommends that the management of bird hazard to aviation is primarily an airport´s responsibility. However, there are actions that could be taken by air carriers and especially pilots to assist in reducing the number of bird strikes.

There are many ways to reduce both the probability and severity of bird strikes, including an array of actions that ensure a measurable, positive effect on companies' bottom lines. According to MacKinnon (2004), there are three areas where operators should concentrate efforts: Standard Operating Procedures (SOP); employee training and awareness, and; reporting of bird strikes.

Following MacKinnon (2004), bird hazard SOPs should be developed and included in company publications addressing some areas, among them flight operations (pilots).

All flights must be planned and executed according to proven bird-strike risk reduction principles and techniques. Those are some effective mitigation actions that could be adopted by pilots (Cleary & Dolbeer, 2005; Dekker and Buurma, 2005; Dolbeer, 2006; Eschenfelder, 2005; Eschenfelder, 2006; Flight Safety Foundation, 1989; MacKinnon, 2004; Mendonça, 2008) to reduce the Risk [R] = Probability [P] x Severity [S]:

1 – During the flight-planning phase, review available information on known bird hazards at the departure point, flight route, arrival airport and alternate airport planned for the destination or enroute [P];

2 – Take time when approaching the aircraft to observe bird activity in the immediate area [R];

3 – During preflight walk-around be alert for signs of nesting birds in all airframes cavities and around the engines [P];

4 – When obtaining the Automatic Terminal Information Service (ATIS) and any other information from Air Traffic Controllers (ATC), note any report of bird activity [P];

5 – During preflight preparation, heat the windshield (if possible) since it may increase both windshield pliability and its ability to withstand bird impacts [S];

6 – Prior to engine start and during pre-flight reviews of aircraft emergency procedures consider courses of actions that may be necessary in case of a bird strike [S];

7 – Be alert while taxiing, noting any reports by ATC and other aircrafts. Also, report any activity on ramps, taxiways and runways to ATC [P];

8 – While rolling onto the runway, prepare yourself (and/or the crew members) mentally to deal with the consequences of a strike during takeoff. Be aware of conditions that will affect pilots' ability to either reject takeoff or continue flying under reduced aircraft performance [S];

9 – Whenever possible, avoid takeoffs directly into the rising or setting sun since it may be difficult to see and avoid even large flocks of birds along the takeoff and climbout paths [P];

10 – Before commencing takeoff check the runway for birds standing on concrete and asphalt surfaces [P];

11 – Use landing lights during takeoff, approach and landing. Although there is no conclusive evidence that birds see and avoid landing lights limited data suggest that landing lights-particularly pulsed landing lights- make aircraft more visible to birds and give more time for the animals to take evasive action. It is suggested that landing lights should be on whenever flying below 10,000 ft above ground level - AGL [P];

12 – Select engine ignition on for takeoff roll to enhance engine flameout protection when operating turbine-powered aircraft in the presence of birds [S];

13 – Be prepared to adjust the climb route to avoid birds [P];

14 - Plan the flight to operate at the highest possible altitude since the probability of bird strikes decreases dramatically above 3,000 ft AGL and emergency situations are more challenging at low altitudes [P];

15 – In case there is reported bird activity, plan to operate at reduced airspeeds to minimize impact force and aircraft damage [S];

16 - If there is an altitude band where birds are anticipated climb through these altitudes as expeditiously as possible using the manufacture’s recommended best rate of climb speed [P];

17 – While enroute, listen to ATC and other aircraft to obtain up-to-date information on bird activity [R];

18– Plan aircraft descent and approach to avoid high-risk areas [R];

19 – During descent and approach in high-risk areas reduce airspeed to diminish the severity of potential bird strikes [S];

20 – Use a higher rate of descent in areas with reported bird activity without increasing airspeed to minimize exposure to potential bird strikes [R];

21 – If any doubts exist concerning safety due to bird hazard during approach and landing delay landing, until conditions are safer. Pilots should also consider asking ATC for another runway or even to divert to another airport [P];

22 – If birds are encountered during approach, consider a go-around and a second approach but only if the go-around can be initiated without striking birds after power is increased [P];

23 – When suddenly confronted with birds pull up, consistent with good piloting technique, to pass over the birds. They seem initially to attempt to maneuver away from conflicting airplanes. In some cases birds dive since they will not have enough flight energy to attempt a sudden climb [R], and;

24 – Report bird hazards and bird strikes following ICAO procedures established in its Manual on the ICAO Bird Strike Information System Manual (ICAO, 1989) [R].

Before a problem can be solved, it must be understood. A mandatory and first step toward understanding and solving the complex problem of collisions between aircraft and birds is the collection and analysis of bird hazards (Cleary & Dolbeer, 2005). Therein lies the bird hazard report, as an important document that feeds the safety management system.

According to Manuele (1997), hazard analysis is the most important safety process. “If that process fails, other processes are likely to fail” (p. xiii). Safety professionals are required to give advice on hazard reduction after those hazards are analyzed and categorized as to their severity and likelihood. The bird hazard report works as an important tool to feed those professionals with valuable pieces of information that will lead to risk reduction of accidents and incidents in the work environment.

Until recently flight crewmembers were passive participants in bird hazard mitigation. Aircraft and engine design and certification and bird hazards were such that

there was little need for pilots action. This situation is no longer acceptable. Pilots are required to assure the safety of their flights (Eschenfelder, 2006).

4 METHODOLOGY

The research consisted of a survey administered to Brazilian Airlines pilots to assess their perceptions and their knowledge regarding recommended practices that could reduce the risk of accidents due to bird hazard. A quantitative-descriptive research focused on perceptions, comprising beliefs and values regarding the bird hazard, was used to collect data.

Considering that the pilots targeted possess the information sought by the survey, that the risk of bird hazard is always present in the aviation environment, and that there are major factors that qualify respondents and make their answers meaningful to the research, the purposive sampling was used to assess the pilots' perceptions (Leedy & Ormrod, 2005).

Purposive sampling focuses on the in-depth exploration of selected key informants who possess direct connections to various essential and effective data resources (Maykut & Morehouse, 1994; Marshall and Rossman, 1999). It is a strategic method in which particular informative persons or experts are "selected deliberately in order to provide important information that can't be gotten as well from other choices" (Maxwell, 1996, p.70).

A survey questionnaire with 29 close-ended questions and two open-ended questions was developed. Based on safety theories concepts, bird hazard previous studies, SMS manuals and documents, safety management systems objectives and requirements, the instrument considered possible areas of concern for pilots to reduce the risk of bird strikes.

A Likert scale was used to record the perceptions of the panelists in five levels, being 5 – Strongly Agree, 4 – Agree, 3 – Do not Agree or Disagree, 2 – Disagree, and 1 –

Strongly Disagree. To answer the questionnaire, the pilots were asked to choose the number in the scale that best suited their perception about a given statement. It was assumed that pilots' responses could vary from total disagreement to complete agreement with each assertion, according to personal perceptions of the subjects.

Lupoli (2006) suggests that open-ended questions can provide a better qualitative data from the perception of the panelists by allowing them to express their opinions about some issues. The participants were also encouraged to expand their ideas and make comments concerning pilot procedures that can reduce the risk of bird strikes.

4.1 Instrumentation

An anonymous self-administered survey questionnaire was sent to three airlines' pilots through their safety departments. The companies' Flight Safety Officers asked their pilots to help the researcher conduct the study, informing them about the possible safety benefits that would come out as a result of the research project not only for their companies but also to Brazil. They were also solicited to send their responses directly to the researcher.

5 RESULTS AND DISCUSSION

The growth of bird populations and aviation is undeniable. It is inevitable that conflict between aircraft and birds will increase. Thus, effective mitigation to ensure the highest level of safety must be implemented (Eschenfelder, 2005). Pilots, through adequate planning and the use of appropriate aircraft operating techniques, play a significant role in reducing the risk of accidents due to bird strikes.

Question 1 asked about the pilots' experience in the aviation environment. The subjects reported a great deal of experience in the aviation field, accumulating many years of experience. The pilots who replied to the survey questionnaire were predominantly

experienced professionals who had been working in the aviation environment for more than ten years (69%), and only 20% of them had less than five years of experience. Among the respondents, 53% were first-officers and 140, representing 47% of the population were captains.

Among participants, 84 declared to be certified by the Brazilian Aeronautical Accidents Prevention and Investigation Center (CENIPA), representing 28% of the respondents. That means that those pilots have attended at least one safety course provided by CENIPA. Apart from that, the subjects reported a great deal of experience in the safety environment, with 212 pilots, representing 82% of the population, attending at least one aviation safety course. These results illustrate that safety knowledge is considered important in pilots' background.

The survey results indicate that the majority of participants have significant professional experience in the aviation industry, probably associated with a significant amount of flight time accumulated. This is an important consideration because in their careers those pilots have had contact with safety issues through initial and recurrent training in their companies. Since birds have posed not only a potential but a real hazard for aircrafts, it is believed that airlines should address this theme during those trainings for aviators. Thus, pilots are supposed to know some procedures and techniques to avoid bird strikes

The great majority of pilots (54%) agreed that reviewing, during the flight-planning phase, the available information on known bird hazards at the departure point, flight route, arrival and alternate airport planned for the destination or en route portion of the flight, may reduce the risk of bird strikes. Despite that, 25 respondents disagree with that statement.

The majority (23% strongly agreed & 50% agreed) of participants recognized that taking time, while approaching the aircraft to observe bird activity in the immediate area can also reduce the odds of an accident due to bird strikes. Yet, the need to be alert, during the preflight walk-around, for signs of nesting birds in all airframes cavities and around the engines as cited by Dolbeer (2006), Eschenfelder (2006) and MacKinnon (2004) was affirmed by 79% of the pilots. Nevertheless, 16 panelists do not agree with it.

According to Mackinnon (2004), upon listening to the Automatic Terminal Information Service (ATIS) or any other pieces of information provided by Air Traffic Controllers (ATC), to note any reports of bird activity, may reduce the likelihood of bird strikes. Participants (77%) showed through their answers they firmly believe that arrival and departure controllers are indispensable members of the bird-strike risk-management team. This means they understand the vital role of this communication to increase pilots` situational awareness and to enable them to better manage flight profiles. However, 17 pilots did not agree or strongly disagreed with this statement.

Participants are not sure if heating the windshield (if possible) during preflight is a proven bird-strike risk-reduction technique. Although 176 pilots did agree it may increase both windshield pliability and its ability to withstand bird impacts, 36% of respondents disagreed or strongly disagreed with this statement by Mackinnon (2004).

The great majority of participants (43%) agreed or (28%) strongly agreed with statement in question 10, which means that they are very conscious that prior to engine start and during pre-flight reviews of aircraft emergency procedures, crews should consider courses of actions that may be necessary in case of a bird strike. However, 85 out of 296 respondents did not agree in some degree with this principle, which means that not all pilots are familiar with this underpinning of the risk management process.

Takeoff is a critical phase of flight. Pilots demonstrated awareness of the risks posed by during takeoff, thus they strongly agreed (97%) that they should be alert while taxiing for takeoff, noting any report by ATC or other aircraft. Yet, they should also report any bird activity on ramps, taxiways and runways to ATC. They also agreed to some degree (88%) that they should mentally prepare themselves while rolling onto the runway so as to deal with the consequences of a bird strike during takeoff. Being prepared for such a condition can be the difference between an accident and an incident. Despite the answers for questions 11 and 12, nine panelists did not agree that they should, prior to start takeoff, check the runway for birds standing on concrete and asphalt surfaces.

Birds stand on concrete runways and asphalt surfaces to warm themselves, to gain a clear view of approaching predators and also to feed on small insects after the grass has been cut. Thus, pilots will reduce the risk of a bird strike if they check the runway for those birds before commencing takeoff. Pilots were strongly convinced, according to 220 responses in question 13, with a significant 33% of answers in “strongly agree,” the most extreme level of the rating and 42% in “agree” level, confirm pilots’ familiarity with the risk management process.

The use of landing lights during takeoffs and landings make the aircraft more visible to birds and provide more time for the animals to take evasive action. It is also recommended that lights should be on whenever flying below 10,000 ft AGL. Although there is no conclusive evidence that birds see and avoid aircraft lights, 76% of the pilots agreed to some degree with the statement in question 14. Moreover, 54% of respondents do turn landing lights on whenever flying below 10,000Ft. However, it can be assumed that 68 do not turn the landing lights on as a technique to reduce the risk of bird strikes.

Question 16 was designed to verify if pilots would recognize that they should select engine ignition on for takeoff to improve flameout protection in the presence of birds. The answers evidenced that only 43% of participants use this technique to prevent an accident due to birds.

The great majority of participants (73%) showed a good understanding of the importance of adjusting the climb route to avoid birds. This is likely to reduce the probability of bird strikes, thus reducing the risk of a mishap.

One of the elements of the risk management process was reflected in the answers for questions 18 and 20. Pilots (67%) indicated that they know that when they plan the flight in order to operate at the highest altitude as soon as possible they will reduce the rate of exposure to the hazards, in another words they will reduce their exposure to unsafe conditions, thus reducing the risk of a bird strike. By the same token, 62% of respondents agreed and 27% strongly agreed that the manufacturer's recommended best climb rate should be used to climb through the altitude block where birds are anticipated so as to reduce exposure to hazards (ICAO, 2005).

Questions 19 and 23 addressed a subject of concern in aviation safety. MacKinnon (2004) recommended that if there is reported bird activity or if an aircraft is to fly in a high-risk area, pilots should plan to operate at reduced airspeeds. Participants (72%) were convinced that this could reduce the outcomes of a bird strike; however, 76 pilots showed their concerns about reducing the speed and the risk of a stall due to a maneuver to avoid birds, especially if flying close to the ground.

Answers to question 23 showed that 189 participants know that by maintaining lower safe airspeeds in areas frequented by birds may minimize the potential for a strike and also reduce the impact force should one occur. However, there were 65 pilots who did

not agree or even strongly disagree with this recommendation by the Flight Safety Foundation (1989).

Air traffic control personnel must advise crewmembers of any unsafe conditions, including hazardous wildlife on or close to airports (Cleary & Dolbeer, 2005). Pilots have the responsibility to advise the airport tower or the air traffic control center whenever bird activity is observed so that other aircraft in the area can be alerted. Pilots revealed correct knowledge of the bird-hazard risk-management process when they recognized, through their answers (72%) to question 21 that they should listen to ATC and other aircraft (which implies that they should also report) so as to get current information on bird activity. However, 30 pilots to some level did not trust on this technique.

Approach and landing are critical phases of flight. Last year in Brazil 21% of bird strikes occurred during those phases. Participants (62%) considered the importance of planning aircraft descent and approach in order to avoid mishaps strikes a fundamental feature to enhance safety, shedding some light on the findings of previous research studies by MacKinnon (2004) and Eschenfelder (2005).

Based on pilots' answers provided in question 24 (only 47% agreed), it can be assumed that they do not know that they should use a higher rate of descent without increasing airspeed in areas with reported bird activity. According to MacKinnon (2004), this procedure will minimize exposure to potential bird strikes.

Pilots sometimes suffer pressure to keep their flights as scheduled. This was probably the main result from answers to question 25. This result in which some participants (43%) did not agree in some degree that they should, during approach and landing, delay landing until conditions are safer if any doubts exist concerning safety due to bird hazard, is also supported by some answers provided in questions 26 and 27.

According to replies to question 26, pilots (49%) will not ask ATC either for another runway or for a diversion to another airport in order to prevent bird strikes. Although 57% of respondents will consider a go-around and a second approach if birds are encountered during approach, 88 out of 296 will proceed with their approach and landing procedures despite the risk of bird strikes.

One idea retrieved from answers to question 29 led to a better understanding of the aforementioned. Although some pilots support the idea of delaying the approach or landing procedures, they said that due to higher concentrations of birds near certain airports this technique will not reduce, in a daily basis, the risk of bird strikes. According to three pilots, if one delays the approach procedures, the probability of strikes will be increased just because they will have to keep on flying (augment exposure).

Dekker and Buurma (2005) stated that bird hazard statistics are the main source of information for three processes: scientific techniques on bird hazard databases will help understand the problem and present ways to new approaches with increased safety in the future; educational, since databases are of value to educate new workers in the field, and the general public who uses information from the past; and ultimately quality assurance, since bird strikes are the currency with which the effectiveness of preventive programs is measured. Eshenfelder (2003) stated that databases also provide information to the aviation industry to improve the resistance of bird impacts on aircrafts and to establish operational procedures of airlines.

The results (74%) show that pilots are motivated, proactive and somehow committed to report hazards. However, 29 pilots do not agree or strongly disagree with this cornerstone of the safety process. Following Mendonça (2008), some ideas could be retrieved from their replies: the guidelines to report bird hazard must provide training

guidance for aviation personnel; the bird hazard report should be better divulged and made available by many means; it should be defined situations in which a bird hazard is to be reported; and finally, the report could be made easier to comprehend so that not only "safety professionals are able to understand them," but also every person who wants to know about reporting bird hazards.

Pilots are usually the last domino piece before a mishap occurs, and most of the time they are also the last people who could avoid an accident. But they are also the ones who are always in contact with all sorts of hazards. The bird hazard report allows the pilots to let safety professionals investigate each single hazard, and it is considered a big step in the accident prevention effort and consequently enhances the effectiveness of the report (Cleary & Dolbeer, 2005; Dekker and Buurma 2005; Dolbeer, 2006; Eschenfelder, 2006; Mendonça, 2008).

At last the pilots were asked to expand their ideas and provide additional comments concerning pilot procedures that can reduce the risk of bird strikes and their answers are summarized below:

> "It seems to me that, despite being correct and useful to reduce the risk of bird strikes, some procedures are almost impossible;"
>
> "Since pilots must comply with ATC procedures and instructions, some actions by crewmembers are impracticable;"
>
> "Due to fuel restrictions, airport slots, ATC aircraft congestion management, I cannot follow some of those procedures;"
>
> "The concept is correct, however almost impossible to follow due to some problems when it comes to the airline industry environment;"

"There are some constraints crewmembers face daily, for instance commercial (especially due to time pressure - shorter turnaround times by airlines), which frequently hinder pilots actions to avoid bird strikes;"

"The information pilots have regarding bird activity close to the airport has no credibility once it is a continuous broadcast of recorded *noncontrol* information. What I mean here is that, for example, in an certain terminal area (even during the cold nights, where bird activity is not likely to happen), ATIS information advise pilots to be on the alert for birds in the vicinity of the airdrome;"

"Normally, during approach phase bird strikes are more likely to occur while on final approach (almost never during initial descent or others phases of the flight";

"The only recommendation I have ever heard to prevent bird strikes was to keep the radar on during initial climb and/or descent;"

"It is unknown if it would be better to deviate from birds or to keep the course and expect the birds themselves to swerve from the plane";

"It is hard to maneuver a big jet to avoid a bird strike";

"I do not know if it is true or if there are research studies about using the radar to scare the birds away; however, many pilots consider this as a good technique";

"One should never change their flight paths to avoid birds since birds will dive to avoid the plane".

Training is the cornerstone of any business plan, and safety training is no exception. Safety training helps employees develop the knowledge and skills necessary to comprehend and identify workplace hazards and protect themselves (Wells & Rodrigues, 2003).

Excellence in professionals' activities requires technical and mental skills, and both are acquired and maintained through training and practice (Reason & Hobbs, 2003).

Employees are urged to develop and apply their skills and knowledge to improve organizational safety. Safety training and promotion are important features that help employees develop the skills and knowledge needed to comprehend workplaces hazards and protect themselves and especially to shape their professional culture (Helmreich & Merrit, 1998).

Reasonable explanations for the previous findings in which pilots do not agree or even strongly disagree with best practices towards reducing the risks of bird strikes can be found in answers to the last two questions of the survey questionnaire. Although 132 pilots affirmed that most procedures expressed in the questionnaire were presented to them during their initial training, 55% of the respondents stated that they were not.

Some comments provided in question 29.2 indicated a possible flaw in the safety process towards reducing the risk of bird strikes. Only 37% of participants agreed that most of these procedures are reviewed during recurrent training in their companies.

Safety training provides pilots with the motivation and the skills to be proactive towards safety. Training must be planned, continuous, and have measurable results in order to be effective. All too often, individuals participate in training because they have to, and do not firmly believe in its benefits. According to Manuele (2003), for training to be successful, participants should understand that the information being conveyed is practical to them and to their work tasks.

Permanent and correct training influences the safe culture of an organization, and motivates its employees to be proactive in safety procedures in addition to increasing their safety awareness (Helmreich & Merrit, 1998; Soeters & Boer, 2000).

The aviation industry lends itself pretty well to procedures and best practices to be followed by pilots to reduce the probability and/or severity of a bird strike. Almost everyone in this environment has a strong personal interest in safety, and it does not take much effort to get them involved. This observation does reflect the Bird Strike Committee´s point of view.

6 CONCLUSION

Throughout this report, it is possible to identify the importance of airlines' pilots as stakeholders in safety programs, and also identify possible constraints and flaws that, despite endangering the efficacy of Bird Hazard Management Programs, are not difficult to resolve.

A paramount element of any safety program for bird hazard is training and education. Through training, employees will be sufficiently informed about hazards in their working environment to which they may be exposed, thus being able to participate actively in their own protection. Training will also increase worker productivity, improve personnel and processing flexibility, facilitate uptime, reduce costs, reduce hazards in operational activities, and achieve effective environmental control upstream.

In organizations with superior safety records, training is serious business. Training should take place in many ways, and must be a continuing and never ending process. Safety training must be well planned, continuous, and measured for results. Personnel must believe that the content of their training program is what top management expects them to apply, and that it serves real knowledge and skill requirements. Employees may not follow work practices if they have not been instructed in the proper procedures. Training will also show them that they are part of an organization that gives high priority to safe performance. This finding echoes Mendonça`s conclusions in 2008.

Workers must understand their roles and responsibilities within the safety health of their companies. Training will foster a safety culture. Safety training will not only provide the necessary knowledge for pilots to manage the risk of bird strikes, but also motivate them to do so.

Despite the great majority of agreement by pilots that they know situations and procedures they should adopt to reduce the risk, a significant number of participants lacked the necessary knowledge for doing so. The main explanation for that was retrieved from answers to the last two questions. Only 45% of respondents stated that they were presented safety procedures towards reducing the risk of bird strikes, and just 37% agreed or strongly agreed that they were presented those procedures during periodic training. Thus, without the necessary skills and motivation, it is not an easy task to get pilots to be proactive and motivated in this process.

Committing employees in programs that directly affect their health and safety environment, in addition to having a moral connotation, makes a good business sense for the following reasons: workers, who are most in contact with hazards, will have a vested interest in effective preventive programs; line workers, like pilots, have deep knowledge of their jobs, and have proved to be very effective problem solvers; they support program that include and depend upon their input; and encouraging employee involvement, coupled with taking their contribution and ideas seriously increases job satisfaction, leading to increased productivity.

Pilots, concurring with Wells and Rodrigues (2003), agreed that they, as the last barrier to avoid a bird hazard, many times without the resources and adequate training to assess the risks, have a vested interest in an effective bird hazard program. The result only

reinforces that it is not a headache to get pilots proactively involved in safety programs, including those aiming the avoidance of bird strikes.

Airlines face a diversity of risks daily, among them the risk of aircraft accidents due to bird hazard. Many of those risks, within their own concepts imply uncertainty, are capable of compromising the viability of an airline. Bird hazard is a by-product of the aviation industry. Not all risks of bird hazard can be eliminated, nor are all imaginable risk mitigation measures economically feasible (ICAO, 2009).

Using the risk management process is vital in achieving an acceptable level of risk for the design, the operation, and the task performance aspects of safety. Pilots demonstrated good knowledge of the risk management process. They, concurring with Cleary & Dolbeer, 2005; Dekker and Buurma, 2005; Dolbeer, 2006; Eschenfelder, 2006; Flight Safety Foundation, 1989; MacKinnon, 2004 and Mendonça, 2008, acknowledged that formal education and training should be given to all pertinent members of the aviation industry. Moreover, companies should provide pilots with guidance on how to mitigate bird hazard during their initial and recurrent training.

An array of mitigations actions and recommendations are available to stakeholders of the aviation industry, especially airport operators; however, there is almost no training for pilots regarding best practices that could reduce the risk of aircraft accidents due to bird strikes.

Air operators should focus their efforts on the development of bird-hazard Standard Operating Procedures – SOPs, which should be included in company publications addressing different areas, among them initial and recurrent training for pilots. There is no doubt that best practices by crewmembers will reduce the number of bird strike events or mitigate their impact.

Taking all the above considerations into account, meeting the goals of science, training and education, the risk management and quality assurance processes, and especially the characteristics of the bird hazard issue, it is clear that pilots play an important role towards reducing the risk of bird strikes. Thus, through education and awareness, they will be motivated and really prepared to face the bird-hazard problem.

The forecast growth for the aviation industry in Brazil requires new measures and great effort in order to achieve continuing improvement in the level of aviation safety. Expanding populations of birds hazardous to aviation and increased air traffic by quieter, turbofan-powered aircraft are two of the many reasons for the growing conflict between aviation and birds, not only in Brazil but also all over the world.

Prompting pilots to be proactive in the risk-management process goes beyond compliance with international or national standards. To begin with, this implies safety enhancement, which is an intrinsic requirement of the aviation system. This theme becomes of paramount importance if one considers the IATA forecast, which estimates that we should prepare ourselves for a world of 16 billion passengers and 400 million tonnes of cargo (IATA, 2011). Despite the economic downturn, demand for international air transport continues to grow. World traffic is expected to rise by 4.7 percent in 2011 and 4.9 percent in 2012, with similar growth rates for the rest of the decade and beyond (Graham, 2011).

7 ACKNOWLEDGMENTS

The author would like to thank the following enterprising men for their previous research studies: Arie Dekker; Bruce MacKinnon; Edward C. Cleary; Luit Buurma; Paul Eschenfelder; and Richard A. Dolbeer.

My gratitude also goes to TAM Airlines`, Azul Airlines` and TRIP Airlines` safety professionals and pilots for allowing me to conduct a research project and also for their support and help.

Finally I thank my superiors and friends in CENIPA who always encouraged me to strive for my objectives.

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Dear pilot,

This survey is part of a scientific research designed by Lt Col Flávio Antonio **Coimbra** Mendonça, from the Aeronautical Accidents Investigation and Prevention Center – CENIPA. The questionnaire aims at gathering data to allow a better understanding of two aspects:

1) Your knowledge of procedures that may contribute to the reduction of the risk of bird strikes, and;

2) Common practices that should be focused during pilots' initial and recurrent training in order to prevent aircraft accidents due to bird strikes.

There is no intention to evaluate the safety level of your organization or determine any personal failure. The completion of the questionnaire is anonymous and voluntary, and the answers will be kept confidential. The success of this endeavor depends on your voluntary participation.

As a pilot with a master's degree in aviation safety, I value the experiences of professionals who work in aviation and face daily risks related to bird hazard. Considering your experience in the aviation environment, your opinion is paramount for the development of new strategies towards preventing aircraft accidents. It is important to remind you that there is no right or expected answer in the questionnaire. I request your support to answer the survey, which takes about fifteen minutes to be completed.

For answering the multiple choice questions, you just have to put the cursor over the box near the item you want to mark and press the mouse button. An "X" will appear inside the box and, if you want to change the answer, all you have to do is to click again in the marked box, and the "X" will disappear. For the essay question, you just have to put the cursor over the area bellow the

question and click with the mouse button, this will immediately activate the field with no size limits for the text you want to insert.

You are the most important part in keeping the safety engine running properly within your company. Thank you in advance for your attention and for devoting your time to support this project, which, with your experience and knowledge, will surely help to improve safety in relation to the bird hazard.

Please, send your answers to **FCOI@TERRA.COM.BR** at your earliest convenience.

PROFESSIONAL BACKGROUND	
1. How long have you been working in the aviation environment?	Less than 5 years ☐ 5 to 10 years ☐ more than 10 years ☐
2. My actual rank in the company is…	First-officer ☐ Captain ☐
3. Do you have any credentials granted by CENIPA?	Yes ☐ No ☐
4. Have you ever attended a flight safety course?	Yes ☐ No ☐

The planning and operating techniques which follow can reduce the Risk (Risk = Probability x Severity) of bird strikes. For each question, please check one of the following choices that best matches with your own opinion.

5	4	3	2	1
Strongly Agree	Agree	Do not Agree or Disagree	Disagree	Strongly Disagree

5. To review, during the flight-planning phase, the available information on known bird hazards at the departure point, flight route, arrival and alternate airport planned for the destination or en route portion of the flight.	5☐ 4☐ 3☐ 2☐ 1☐

6. To take time while approaching the aircraft to observe bird activity in the immediate area.	5☐ 4☐ 3☐ 2☐ 1☐
7. To be alert, during the preflight walk-around, for signs of nesting birds in all airframes cavities and around the engines.	5☐ 4☐ 3☐ 2☐ 1☐
8. Upon listening to the Automatic Terminal Information Service (ATIS) or any other pieces of information provided by Air Traffic Controllers (ATC), to note any reports of bird activity.	5☐ 4☐ 3☐ 2☐ 1☐
9. During preflight preparation, to heat the windshield (if possible), since it may increase both windshield pliability and its ability to withstand bird impacts.	5☐ 4☐ 3☐ 2☐ 1☐
10. Prior to engine start and during pre-flight reviews of aircraft emergency procedures, to consider courses of actions that may be necessary in case of a bird strike.	5☐ 4☐ 3☐ 2☐ 1☐
11. To be alert while taxiing for takeoff, noting any report by ATC or other aircraft. Yet, to report any bird activity on ramps, taxiways and runways to ATC.	5☐ 4☐ 3☐ 2☐ 1☐
12. To mentally prepare yourself (and/or the crew members), while rolling onto the runway, so as to deal with the consequences of a bird strike during takeoff (to be aware of conditions that may affect pilots' ability to either reject takeoff or continue flying under reduced aircraft performance).	5☐ 4☐ 3☐ 2☐ 1☐
13. Before commencing takeoff, to check the runway for birds standing on concrete and asphalt surfaces.	5☐ 4☐ 3☐ 2☐ 1☐
14. To use landing lights during takeoff, approach and landing.	5☐ 4☐ 3☐ 2☐ 1☐

15. To turn landing lights on whenever flying below 10,000 ft AGL.	5☐ 4☐ 3☐ 2☐ 1☐
16. To select engine ignition on for takeoff roll when operating turbine-powered aircraft in the presence of birds.	5☐ 4☐ 3☐ 2☐ 1☐
17. To be prepared to adjust the climb route in order to avoid birds.	5☐ 4☐ 3☐ 2☐ 1☐
18. To plan the flight in order to operate at the highest altitude as soon as possible.	5☐ 4☐ 3☐ 2☐ 1☐
19. If there is reported bird activity, to plan operation at reduced airspeeds.	5☐ 4☐ 3☐ 2☐ 1☐
20. If there is an altitude block where birds are anticipated, to climb through these altitudes as expeditiously as possible, using the recommended best climb rate.	5☐ 4☐ 3☐ 2☐ 1☐
21. While en route, to listen to ATC and other aircraft so as to obtain up-to-date information on bird activity.	5☐ 4☐ 3☐ 2☐ 1☐
22. To plan aircraft descent and approach in order to avoid high-risk areas.	5☐ 4☐ 3☐ 2☐ 1☐
23. To reduce airspeed during descent and approach in high-risk areas.	5☐ 4☐ 3☐ 2☐ 1☐
24. To use a higher rate of descent in areas with reported bird activity, without increasing airspeed.	5☐ 4☐ 3☐ 2☐ 1☐
25. During approach and landing, should any doubts exist concerning safety due to bird hazard, to delay landing until conditions are safer.	5☐ 4☐ 3☐ 2☐ 1☐
26. To ask ATC either for another runway or for a diversion to another airport in order to prevent bird strikes.	5☐ 4☐ 3☐ 2☐ 1☐

27. If birds are encountered during approach, to consider a go-around and a second approach.	5☐ 4☐ 3☐ 2☐ 1☐
28. To report bird hazards and bird strikes by filling out a CENIPA 15 form.	5☐ 4☐ 3☐ 2☐ 1☐
29. Please, use this space to provide additional comments concerning pilot procedures that can reduce the risk of bird strikes.	
29.1. Most of these procedures were presented during the initial training in my company.	5☐ 4☐ 3☐ 2☐ 1☐
29.2. Most of these procedures are reviewed during recurrent training in my company.	5☐ 4☐ 3☐ 2☐ 1☐