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AVIATION FACULTY

DEPARTMENT: AIR TRAFFIC CONTROL

NURMUKHAMEDOV TOKHIR RUSTAMOVICH

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Research of the safety issues on the runway area

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Supervisor:

Eshmuradov D.E.

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Аннотация

Рассматриваются вопросы исследования вопросы безопасности в зоне взлета и посадки при ожидаемых роста интенсивности полетов в нашей Республике. Сделан анализ работы всех соотрудников аэропорта играющих не посредственно в обеспечении безопасности. Тем самым, рассматривались вопросы по расширению вариантов решения возникаемых проблем при управлении воздушным движением.

Аннотация

Хозирги кунда республикамиз худудида парвозлар кетма-кетлигини жадаллаши кутилаётган холдаги учиш- қўниш худудида хавфсизлик масалалари кўриб чиқилган. Хавфсизлик масаласига доир бўлган аэропортдаги барча хизматчиларни фаолиятлари анализ қилинган. Шу орқали, хаводаги харакатни бошқариш жараёнида юзага келадиган муаммоларни хал этиш чораларинини кўпайтириш масалалари кўриб чиқилган.

THE ANNOTATION

In this work, are considered safety issues in the runway area meantime appreciating the increase of air traffic in our republic. There was conducted the activity analyses of all concerning airport service employees who are directly connected to the safety issues. Thus, were considered increase of options concerning safety while providing air traffic control.

CONTENT

INTRODUCTION

Ramp safety is a major safety concern in the aviation industry. Obviously so because the airport's ramp area involves activities and movements from various aircraft, vehicles, equipment and people. More so, it accommodates personnel and contractors from different players like airport operations and maintenance staff, airport police, fire brigade, airport and airline engineers, planners and other regulatory and security personnel - all performing different activities and tasks everyday.

A large chunk of the industry's loss and expenses can be attributed to accidents and incidents in this very dynamic, complex and intensely busy area of the airport wherein which majority of these incidents are caused by human errors. Ramp accidents are considered one of the major problems in the industry and a major concern all airports are taking seriously nowadays. Experts believe that there is an estimate of more than $5 billion a year airline loss brought about by ramp damage, typically caused by collision between ground service vehicles and parked aircraft.

According to the issue of Aerosafety World, the Flight Safety magazine based their report from the International Air Transport Association estimating that there were twenty-seven thousand ramp accidents each year wherein which 240,000 people were injured. Such numbers caused an alarming concern in the aviation industry. However, some contest that the figures are not accurate since some incidents that which are minor and not damaging are not reported.

Not only are ramp workers/personnel involved in these huge number but also flight crew and passengers. Ramp accidents vary and range from ordinary to serious and dangerous. All these can be primarily attributed to human error. Further IATA says that about 92% of these incidents resulted from failure to follow standard procedures, lack of proper and adequate training and airfield congestion.

1.1.The main factors influencing to the danger of the aircraft collisions on the runway

In the early years of aviation, all airplanes operated from relatively unimprov ed airfields. As aviation developed, thealignment of takeoff and landing paths cent ered on a well defined area knownas a landing strip.Thereafter,therequirements of more advanced airplanes necessitated improving or paving the center portion of the landing strip.The term "landing strip" was retained to describe the graded area surr ounding and upon which the runway orimproved surface was constructed.

The main goal of the ensuring the safety of the flight near the runway area is to decrease the risk of danger outcome while performing the flight in maneuvering area and organizing procedures for alerting unathourized entrance to the runway. The main factors influencing to the danger of the aircraft collisions on the runway are:

- adverse meteorological conditions in the runway area
- obstacles on the runway
- increasing intensity of air traffic
- difficult procedures while air traffic management
- conducting the repairing and construction works
- change in airport infrastructure and technics

Landing, take-off and taxiing are the critical phases of flight where the runway becomes place as more possible for aircraft performing the landing or take off with another aircraft (performing take off or running after landing) airfield transports, humans, animals or another objects.

Speedy characteristics of aircraft and their restricted capabilities on performing the maneuvers on runway in the process of take off or landing create potential danger for aircraft collision in possible situations unauthorized entrance (existence) transport means, human and animals which is the hazard to performance of the flight.

International Civil Aviation Organization defined standards and recommendations concerning expluatation procedures with the goal of achieving safety on performing the flight on the runway.

Analyses of runway incursions provide critical measures of aviation safety. These events are analyzed not only to assess the incidence and severity of reportable adverse events, but also to glean information necessary for the development of error mitigation strategies and automated decision aids for pilots and controllers. Traditionally, runway incursions are classified by attribution to pilot deviations, controller errors, or vehicle/pedestrian deviations) and by the severity of their outcome

Increasing intensity of air traffic

In the air transport several groups of participants can be singled out, among others: air carriers, airspace managers, airport managers, passengers. All of them are interested in best possible use of the airspace, resulting in largest possible volume of the air traffic. In such a situation the air carriers take advantage of considerable flexibility in planning timetables of their flights, which in turn enable them to perform large number and frequency of connections and at the same time to adjust them in best possible way to anticipated users needs. The passengers also take advantage in the form of numerous flights in their disposition, adjusted to their preferences in terms of place and time of departure. And profits of airspace and airport managers are directly proportional to number of aircraft and passengers served. However restrictions imposed by the regulations of air traffic make uncontrolled increasing of air traffic volume impossible. The regulations are aimed at keeping safety at appropriately high level. Incessant increase of traffic volume can result in lowering of safety level – for example greater workload for a controller increase probability of mistakes. The congestions appear in the airports areas, which are generating waiting periods for landing. This in turn complicates the traffic situation and increase probability of occurring danger of an air accident etc. These two contradictory tendencies are inducing question of compromising volume of the air traffic - largest possible, but in the same time assuring maximal level of safety. The problem is very difficult for analytic solution, especially because experimenting on actual air traffic with the aim of obtaining necessary data is not possible. Applying simulation methods of investigation, supported by developed and summarily presented in the article methods of investigating the air traffic safety, based on notion of traffic smoothness, allows developing expedient algorithm for designating best possible traffic volume. The algorithm is based on simulation experiments and observed empirical dependence indicating that both smoothness and security, referred to traffic volume, have one maximum. Additionally, smoothness maximum is "outpacing" security maximum, which makes possible determining best possible volume of the traffic in given sector.

Bird Strikes

A major concern for airplanes during takeoff and landing on runways is the possible collision between the plane and birds. While the incidents are relatively common, the fact gained extra attention following the crash of US Airways Flight 1549, an Airbus A320, into the Hudson River in early 2009. Airports have installed a variety of airport runway safety programs designed to mitigate the risk to planes taking off and landing.

Many airports plant poisonous grass and plants around the vicinity of the airport, which diminish the amount of insects in the area, thereby not attracting birds. The facilities also grow the grass to roughly a foot tall, a principle that prevents certain birds from landing in the area. Specialty programs are used in areas where the bird population is high. Some airports simply employ personnel with shotguns, designed to kill and scare off large amounts of birds. Others use falconers who send out birds of prey to kill smaller species. However, the most common method of preventing runway bird strikes is to simply play recordings of predators over speakers

Lighting and Markings

Since the beginning of the aviation industry, pilots and ground personnel have utilized a system of lights and markings to make sure planes are guided to the correct location. Modern airport runway safety programs make use of international regulations and stipulations that mandate certain criteria. Lights of different colors are placed along the edges, either end and along the center line of the runway in an effort to keep planes on track for landing and takeoff. There are also additional lights placed on the areas designed for touchdown and takeoff, helping the pilot know when to perform certain actions.

Depending on the size and status of the runway, certain markings are placed on or alongside the strip designed to guide the pilot to the correct area for a safe takeoff and landing. The most basic markings indicate the ends of the runway, the touchdown location, a center line and fixed distance markers. Others may include aiming points and horizontal and vertical guides to match instrumentation

One of the most important airport runway safety programs in place around the world is the principle of a runway safety area. This is a certain distance around the runway established as a precautionary measure in the event of problems with airplane takeoffs or landings. Over the years, these dimensions have increased with the increased size and quantity of aircraft. According to the US Federal Aviation Administration, modern recommendations, the runway safety area encompasses a distance of 500 feet in width and 1000 feet from each end.

System of Runway Safety Protocol

Standard operating procedure at airports around the world have established certain protocols to determine what type of incident occurs on a runway when an accident happens. Each definition makes reporting, incident management and investigation easier for officials. These incidents are officially referred to as runway events.

A runway incursion happens when a second plane somehow enters the runway safety area. This can occur if a plane enters the runway on the ground or from the air. Usually this involves pilot or air traffic controller error. In the event a single aircraft uses the wrong runway or taxiway, the incident is considered runway confusion.

A runway excursion is an event in which a single aircraft exits the runway in an unwanted fashion. Sometimes, a pilot may take off too early or the aircraft may exit the runway on the ground from malfunction or poor weather conditions. Overruns, in which the aircraft does not take off in time before the end of the runway is reached, is also an example of a runway excursion. These are the most common types of runway accidents, accounting for 96 percent of accidents between 1995 and 2007 according to the Flight Safety Foundation.

In the Event of an Emergency

In order to maintain the proper standards for all of the airport runway safety programs in place, a number of individuals and groups must be on hand at all times to establish, implement and monitor the proper standards. When a runway event occurs, the airport has its own fire department, first responders and security personnel. These groups are equipped with devices that can place flame retardant material on the runway, put out fires and evacuate passengers in the event of an emergency. Other personnel are hired specifically to keep conditions on the runway safe for takeoffs and landing, such as waterproofing and snow removal.

In all, airport runway safety programs are used in a variety of capacities to keep the airline industry functioning and maintain one of the safest ways to travel.

1.2. The notion of air traffic smoothness

The notion of the traffic smoothness as a measuring tool of estimating traffic quality was verbally formulated in. The formalized representation of connections between smoothness and intensity of the traffic was presented in (Woch 1983), initially for rail traffic then in the following years for generally perceived traffic flow. The road to modification of transport networks in aspects of the traffic smoothness and connections between smoothness and safety of traffic was open.

Direct transferring of traffic smoothness definition, employed in the road transportation, is not possible because of the air traffic peculiarities. For example, stopping an aircraft in midair is impossible. The same is true for keeping a distance between vehicles in the road traffic, which can vary according to changes of vehicles average velocity. In the air traffic distance between aircraft is strictly determined by the regulations and cannot be smaller than so-called minimal separation. As a general measure of the traffic smoothness, relation between number of disturbed flights LZ and overall number of flights LS is proposed. As disturbed flight one can understand a flight with changed parameters (altitude, velocity, time of control point passage etc.) because of safety of the air traffic reasons, e.g. necessity of avoiding dangerous storm areas. Any flight can be disturbed only to certain level. This conclusion is the basis for employing methods of smoothness measuring presented below. Let's mark planned movement trajectory of ith aircraft in control sector as * MPi . It is usually optimal trajectory because of fuel consumption, time of passage and flight characteristics of given aircraft. * MPi trajectory is designated by arranged sequence of an aircraft positions, determining locality of characteristic points of a flight's route, times of their passage and velocity vectors at time of passage.

Difficult procedures while air traffic management

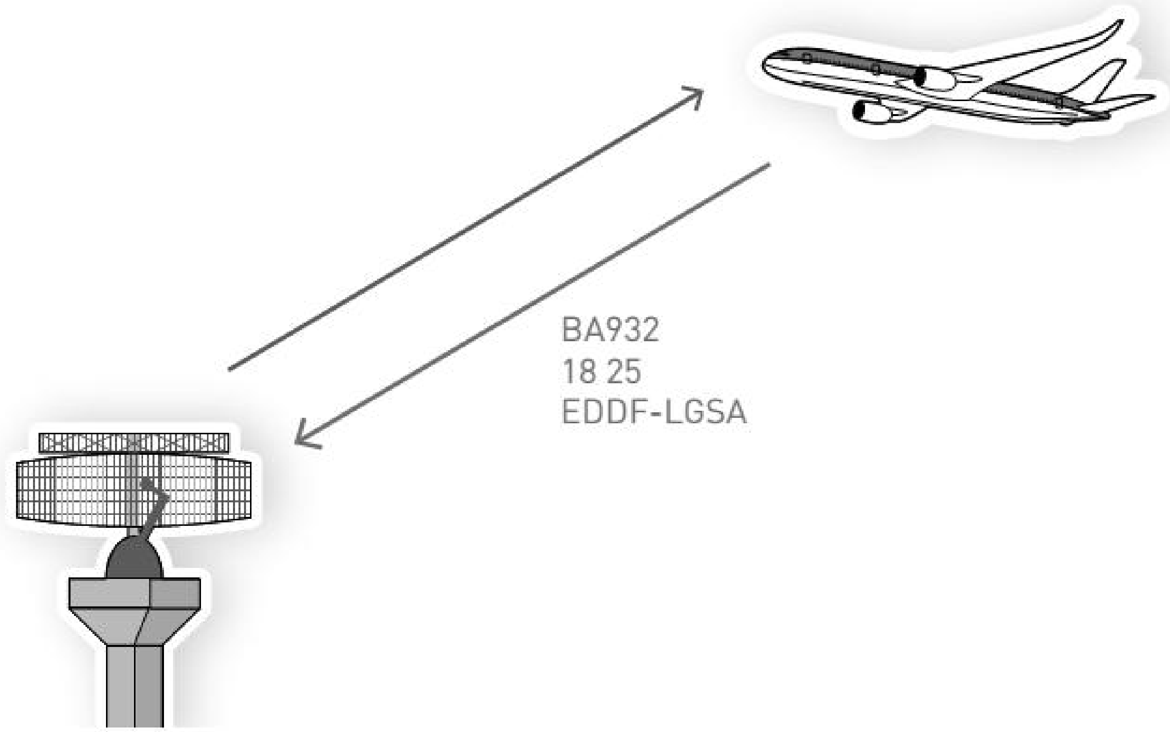
Since the aviation industry first started needing controllers to track aircraft movements in the early 1930s, the introduction of any new technology or operational procedure has been undertaken in a very systematic way and often quite slowly. Safety is our prime consideration and aviation is a cautious industry. We make changes to our operations carefully and after a lot of testing and consultation. It's one of the reasons why we are the safest form of travel. But we are also a very innovative sector and for the last few decades, the technology developments on board our aircraft have often outpaced those in the air traffic control centres. We are now flying jets produced in the 21stcentury along routes that were, in some cases, defined by the placement of radar stations in the 1940s and 50s.This is leading not only to capacity constraints, but also means that the efficiency of aircraft operations is not as good as it could be. So, around the world, technology, collaboration and innovative new concepts are leading to a shift away from air traffic 'control' to air traffic 'management'. The aircraft – and the people that fly them – are being given more decision-making authority over the speed and exact route of their flight than before. They can use the many new navigation and fuel-saving techniques available to them, while increasing the capacity of the skies. However, such capacities are not yet being fully exploited and much more can be done in this area. Improving aviation efficiency is no longer an option but an environmental and business necessity. As fuel now accounts for over one third of the operational costs for the world's airlines and the aviation industry works to find additional ways to reduce its carbon emissions, air traffic management plays an important role. And while new aircraft are becoming ever quieter than their predecessors, new techniques in air traffic management are also allowing for less of a noise impact on the communities around airports.

Air traffic management and planning are not areas in which the industry can act alone. With issues of airspace sovereignty and military restricted airspace, not to mention the fact that most air navigation service providers are state-owned, governments must also play a key role in this evolution. While a lot of the work that the industry can do by itself is technology related, much of the real change can only occur when the institutional arrangements that govern air traffic control are reformed. Current governance restrictions and regulatory capabilities are holding back the ability for air navigation service providers to respond to change. In turn, the ability for aviation to grow and help support national economies is also being constricted.

Every day, over 100,000 flights take off at airports across the world. Some are short hops to nearby destinations; some flights cross the oceans, but all have to fly in the same sky. It is estimated that up to 8% of all aviation fuel is wasted as a result of inefficient routes that aircraft have to fly. But there is an evolution in the global air navigation industry which is already having a profound impact on the way aircraft are handled in increasing numbers, more safely, efficiently and in more environmentally-responsible ways than in the past. The industry can only take this challenge so far – governments will need to look at the very institutional arrangements of their air navigation providers to bring about full efficiencies.

Until recently, air traffic has been managed by routing aircraft into narrow, predetermined routes – much like highways in the sky – originally developed to meet the domestic airspace requirements of countries and often defined by the location of ground-based navigational aids. This has meant that the typical route between two airports has rarely been a truly fuel efficient path. In fact, it is very unlikely that the global air traffic management system will ever be 100% efficient. True efficiency is a single aircraft being able to take off, climb, cruise, descend and land by using the route that takes the least time. In a zero wind situation, the ideal path is the great circle route, but the atmosphere is composed of many ‘rivers’ of air that affect the most efficient path. And there will always be elements that get in the way of true efficiency – weather, closed military airspace and the biggest of all – congestion of other air traffic. The Civil Air Navigation Services Organisation (CANSO) estimates that the current air traffic system is operating at 92% to 94% efficiency, on an average global basis (with some significant regional variations). They have set a goal to reach 95% to 98% efficiency by 2050 – the likely limit of possible efficiency due to the factors mentioned above. However, while it appears we are close to the goal now, it must be remembered that each year’s growth in air traffic can add to the inefficiency, thus making efficiency gains harder to reach. If we do nothing, the system is going to become less and less efficient – this why a revolution in the global air traffic system is needed.

→ HOW IT WORKS: RADAR



Traditionally, most air traffic surveillance has been undertaken using radar. This system is reliable, but requires expensive radar stations. Therefore, in areas of the world where there is little traffic and where having radar stations is physically impossible, there is no coverage of air traffic movements. In these areas, aircraft are kept very far apart. The radar works by sweeping the area it covers with a radio wave and recognising flying objects. Commercial aircraft and many general aviation aircraft carry transponders which emit a signal to the radar with the flight number, speed, altitude and other information. Today, most long-range radar dishes take 12 seconds to rotate. So, air traffic controllers must wait 12 seconds for aircraft positions to update (near airports, with faster-turning radars, the updates are every 5 seconds). For a normal aircraft, this means the plane can have moved over half a nautical mile each time it is ‘pinged’ by the radar. To compensate for this time lag, controllers must maintain wider separation between aircraft. This decreases the useable capacity of airspace.

1.3. Runway related accidents have the second highest casualty rate

It is primary interest, as always, is to safeguard the safety of passengers and crews. Accident statistics show that runway related accidents have the second highest casualty rate. As operational pressures increase from environmental constraints and demands to increase capacity there is the distinct possibility that the accident toll will increase. If the overall accident rate is not reduced then as traffic increases, an increase in the frequency of accidents will, inevitably, increase possibly to the point where the travelling public begin to lose faith in the safety of air transport and thus endanger the viability of the industry.

As a general principle, it is now accepted that runway safety encompasses runway incursions and runway excursions. A runway excursion is defined as when an aircraft departs the runway either by veering off the side or by overrunning the runway end. Meanwhile a runway incursion is when the protected area of a surface of designated for the takeoff or landing of aircraft (paved or unpaved) entered by an aircraft, vehicle or person in error (IFALPA also considers the use of the incorrect runway by a departing or arriving aircraft as an incursion).

Clearly, since runway related accidents form a significant percentage of the overall casualty rate then it is worth addressing the risks associated with runways and set about reducing, mitigating the consequences or removing them all together. Pilots, thanks to the nature of their work are in a unique position to observe and experience different airports and Air Traffic Control (ATC) systems worldwide and therefore are in a unique position to compare and contrast the effectiveness the variables – to see what works and what doesn’t. It is this experience that can be of unrivalled use in determining not only where safety can be improved but also how capacity can be boosted in the most effective way.

This summarises IFALPA’s existing policies aimed at reducing and mitigating the effect of runway related incidents and accidents. In addition, it suggests some new solutions to the challenges posed by runway safety.

International Civil Aviation Organization (ICAO) definition of a runway incursion: Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and takeoff of aircraft. The severity scheme defines runway incursions that involve a conflict between two aircraft or an aircraft and a vehicle or pedestrian with a classification as an A-, B-, or C- category event. A D-category event would only be used in the case of a single aircraft/vehicle or person entering a runway safety area without authorization.

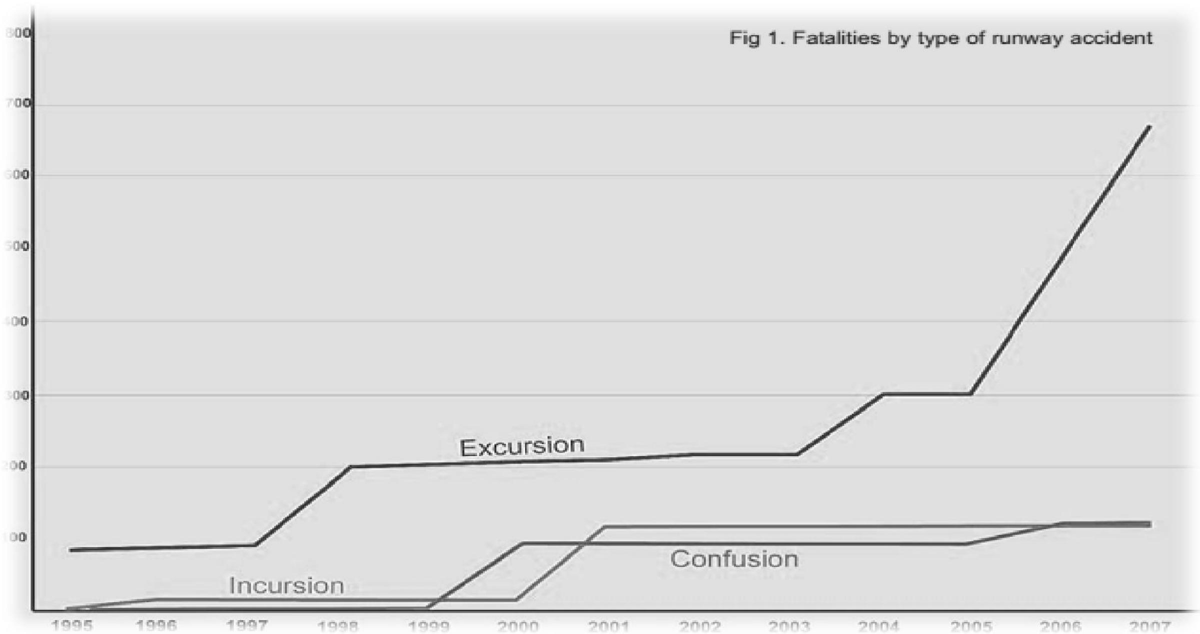


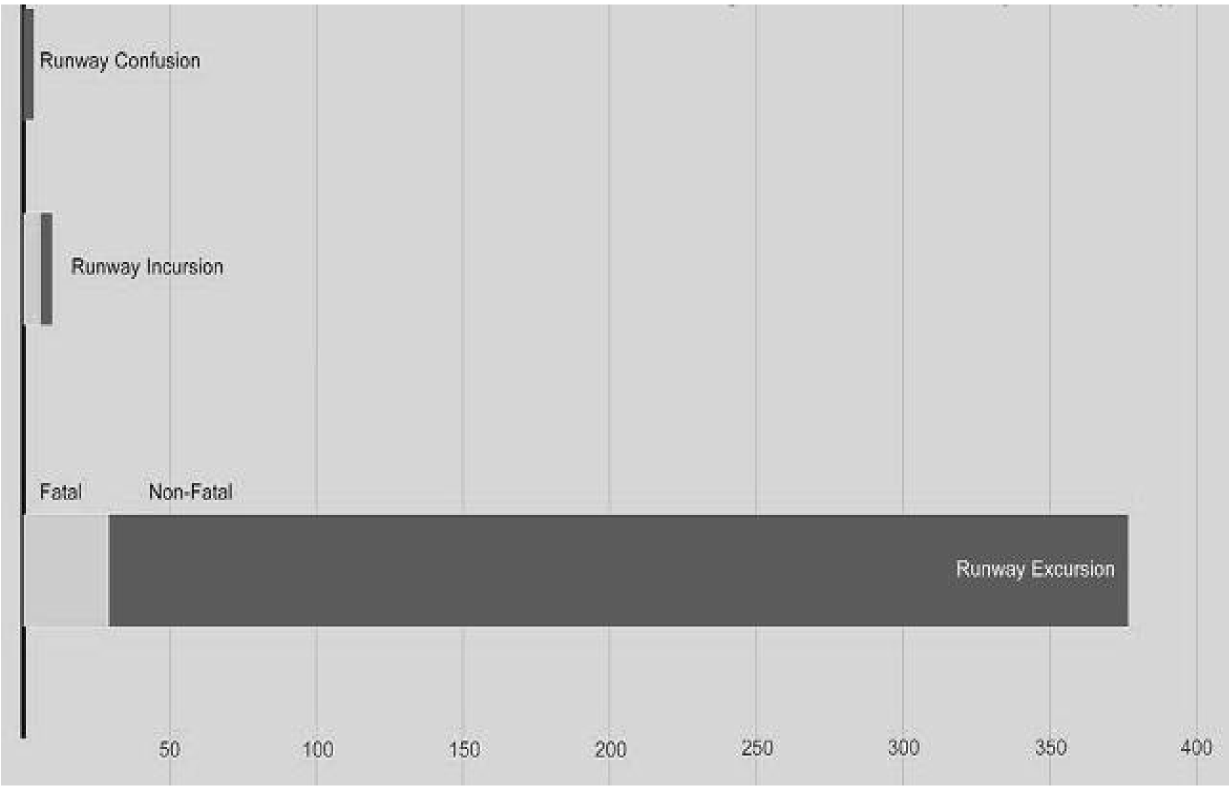
Fig 1. Fatalities by type of runway accident

Runway Excursions- According to research carried out by three groups, The Flight Safety Foundation, the Netherlands Lab R and IATA, runway excursions are now the most common type of event leading to accidentsin commercial operations.

These excursions are generally as a result of a poor approach leading to an abnormal landing or a loss of control on the runway either during takeoff or landing. However, the research has also shown that a runway excursion need not lead to fatalities if the runway area is designed with a view to enhancing post accident survivability. Survivability is further enhanced by fully trained and equipped rescue and fire fighting services (RFF). Since many excursion events have, as part of their factors, poor approach or adherence to procedures it is worth asking the question why this trend is apparent? A study by Prof. Hudson of the

Some universities concluded that pilot experience together with poor or inadequate operating procedures does much to explain these phenomena. Interestingly, since scheduling and time keeping pressures have been cited in a number of reports into runway excursion accidents, Prof. Hudson also found that the commercial and other pressures connected the job of being a pilot was less of a factor.

A good landing generally follows a good approach. Airman defines a good approach as one that it is stable (in other words the aircraft is in landing configuration and stable in speed and flightpath) before reaching 1,000 feet AGL. This reflects the FSF Approach and Landing Accident Reduction (ALAR) programme which says in its Briefing Note 7.1 that there are three essential parameters which must be stable to ensure a safe approach aircraft track (which



could be curved if that type of approach is flown), flight path angle, and airspeed. If an aircraft does not meet these criteria by the 1000ft (IFR) gate (500ft in VFR) then a missed approach or go-around should be executed. If the approach becomes unstabalised after passing the 1000ft gate (for example as a result of windshear or microburst) a go-around should also be executed. Unstable approaches are the result of a number of factors but a recurring theme is the rushed approach resulting in aircraft having an excess of altitude and energy as it reaches the 1000ft gate. Air Traffic Control services (ATC) has a key role to play in the energy management of an approach. The need to maintain higher than ideal speed for spacing, late runway or flight path changes can all lead to rushed, unstabilised, approaches. Standard operating procedures should include the operator’s policy with regard to the decision to go-around encouraging the crews to do so in case the approach is not stabilized. Operators should promote a non punitive “go-around” policy and remind crews that approaches should be discontinued if any safety criteria are not met, for example, an occupied runway, an incursion or unstable approach.

When an aircraft is on final approach, pilots cannot reasonably be expected to “see” an aircraft holding in position, especially at night. Whether the landing lights are on or off would be expected to have little, if any, effect on the pilot’s ability to “see” the holding aircraft - even at night - for two reasons. First, the landing light is not very conspicuous from the viewpoint of an aircraft on approach. In fact, a demonstration conducted by the FAA showed that pilots in a landing aircraft could see the strobe of an aircraft on the ground long before they could identify whether or not the landing light was on. Second, when landing, the pilot’s attention is not focused on the threshold of the runway. Pilots are trained to look at the far end of the runway and the horizon when landing, so that they do not “spot” the runway and land short. While pilots should be accustomed to scanning the runway before landing, a stationary object (as it would be seen during the day) or set of lights (as it would be seen at night, or in haze) would have a tendency to blend into the background; it would not attract attention like a moving object would – especially in the periphery of the visual field. On the other hand, if the use of the landing light was reserved to indicate that the aircraft had received a takeoff clearance, the landing light could be a very useful cue to an aircraft on an intersecting taxiway expecting to cross the runway. Since it can be very difficult to discern movement of an oncoming aircraft, reserving the use of the landing light when initiating takeoff roll would provide other pilots with an indication of the intent of the aircraft in position, that is, whether it is holding in position or taking off. This analysis also revealed that the strategic use of the landing light would be a much more effective mitigation strategy for preventing an aircraft or other vehicle crossing the runway in front of a takeoff than turning the light on while taking the runway would be for preventing a landover. First, an aircraft crossing in front of another aircraft on takeoff roll is a much more likely event than a landover. Second, the strategic use of the landing light has the potential for being much more effective for signaling pilots and vehicle drivers downfield that the aircraft is rolling than it does for increasing the conspicuity of the aircraft to pilots on approach.

Beginning in Fiscal Year (FY) 2008, the Federal Aviation Administration adopted the International Civil Aviation Organization (ICAO) definition of a runway incursion: Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and takeoff of aircraft. The severity scheme defines runway incursions that involve a conflict between two aircraft or an aircraft and a vehicle or pedestrian with a classification as an A-, B-, or C- category event. A D-category event would only be used in the case of a single aircraft/vehicle or person entering a runway safety area without authorization.

This paper presents the results of analyses of recent runway incursions in the world and uses these data to describe:

- Common types of runway incursions involving a conflict between two aircraft or between an aircraft and a vehicle.
- Common types of errors by controllers, pilots, and vehicle drivers that result in runway incursions.

Risk factors for runway incursions and risk mitigation strategies to prevent both the errors that result in runway incursions and to prevent collisions resulting from incursions

Common Types of Runway Incursions

Runway incursions can be described in several ways. The FAA routinely describes incursions in terms of attribution (to OEs, PDs, and VPDs) and the severity of the outcome. Other ways to describe incursions, proposed in this paper, include examining the situations that resulted in the incursions. The first major

Category	Definition of Severity Category
A	Separation decreases and participants take extreme action to narrowly avoid a collision, or the event results in a collision
B	Separation decreases and there is a significant potential for collision
C	Separation decreases but there is ample time and distance to avoid a potential collision
D	Little or no chance of collision but meets the definition of a runway incursion

demarcation in the type of situation that resulted in the incursion is whether the event involved a single aircraft, vehicle or pedestrian (entering a runway safety area without authorization), or a conflict between an aircraft that is taking off or landing and another aircraft, vehicle or pedestrian. These situations, or scenarios, that result in runway incursions can be described in terms of what the aircraft was doing at the time (e.g., taxiing, taking off or landing). It is the situations of runway incursions that involve a conflict with an aircraft landing or taking off that will be described here.

Conflict with a landing aircraft

As in previous years, the most common type of conflict was a taxiing aircraft or vehicle conflicting with a landing aircraft. This includes taxiing aircraft or vehicles crossing the runway or otherwise violating the runway (i.e., crossing the hold short line, crossing the runway edge, or entering the runway) in front of a landing aircraft. (It does not include conflicts with a landing aircraft and another aircraft taking off or landing on an intersecting runway as these events are categorized separately.) Similar to past years, for FY2008, this scenario accounted for 44% of the total number of runway incursions involving a conflict. In the same year, this scenario accounted for 18% of all of the runway incursions. Only 4% of these were the most serious (A- and Bcategory) in terms of outcome, due, in part, to the fact that the majority (59%) of these events resulted in a go-around. Incidents that result in the landing aircraft going around present much less risk of collision that those that involve the aircraft completing the landing. It is also the case that 48% of these events the encroaching aircraft crossed the hold short line, but did not cross the runway edge.

The large difference in attribution of these events between pilots and controllers is likely due to the details behind the definition of a runway incursion used in the world. That is, any incidence of a pilot entering a runway without authorization with an aircraft on approach would be counted as a runway incursion. However, if a controller cleared an aircraft to enter a runway in front of a landing aircraft, the event would not meet the definition of a runway incursion as long as the aircraft on the ground was clear of the runway while the landing aircraft was at least not yet over the threshold or the landing aircraft was instructed to go around before reaching the threshold.

A number of runway incursions result from drivers acknowledging ATC hold short instructions and then proceeding across the runway holding position line anyway.Runway holding position markings on taxiways identify the locations where an aircraft or vehicle is required to stop when it does not have a clearance to proceed onto a runway (you may also see a red and white runway holding position sign and possibly runway guard lights). When instructed by ATC to "Hold Short of Runway XX", you must read back the instruction and stop so no part of the vehicle extends over the first solid line of the runway holding position marking. Keep your head up — distances of runway holding position markings from the centreline of a runway can vary even at the same aerodrome but they are never aligned with the edge of the sealed surface of the runway. When approaching the runway holding position marking, you must not cross the marking without ATC clearance. A vehicle exiting a runway has not vacated the runway unless all parts of the vehicle have crossed the applicable runway holding position marking.

Different Air Traffic Service Providers use different criteria in this regard (all are consistent with the ICAO definition of an incursion). It is important to know the definitions used when interpreting such statistics. Conflict with an aircraft taking off The second most common type of incursion with a conflict in 2008 was a taxiing aircraft or vehicle conflicting with a takeoff. This includes crossing the runway or otherwise violating the runway (i.e., crossing the hold short line, crossing the runway edge, or entering the runway) in front of an aircraft taking off. (This does not include conflicts between an aircraft taking off and another aircraft taking off or landing on an intersecting runway as these events are categorized separately.) This scenario accounted for 37% of the total number of runway incursions involving a conflict. Only 40% of these events were attributed to controller error with 49% attributed to pilot error 11% to vehicle or pedestrian deviations. However, crossings and potential crossings in front of a takeoff was the most common scenario in controller errors involving a conflict, accounting for 43% of the OEs (but only 34% of PDs). While only six of these conflicts with a crossing aircraft resulted in an A- or B- severity outcome, the aircraft continued the takeoff (as opposed to aborting) in almost half (47%) of these instances, creating a potentially serious situation.Other scenarios When combined, taxiing aircraft and vehicles crossing (or potentially crossing) in front of landings and takeoffs accounted for the vast majority (80%) of the incursions involving a conflict with another aircraft (and 33% of all of the runway incursions in FY2008). The remainder involved different configurations, such as operations on intersecting runways operations on intersecting runways (9%), and two operations on the same runway in the same (8%) or opposite (1%) direction. An additional 1% involved a conflict with a stationary aircraft or vehicle on the runway.

This analysis also revealed that the strategic use of the landing light would be a much more effective mitigation strategy for preventing an aircraft or other vehicle crossing the runway in front of a takeoff than turning the light on while taking the runway would be for preventing a landover. First, an aircraft crossing in front of another aircraft on takeoff roll is a much more likely event than a landover. Second, the strategic use of the landing light has the potential for being much more effective for signaling pilots and vehicle drivers downfield that the aircraft is rolling than it does for increasing the conspicuity of the aircraft to pilots on approach. The potential for use of the landing light as a signal that the aircraft is taking off is powerfully endorsed by Captain Robert Bragg, who was the Pan Am first officer in the 1977 crash of two B-747s on the runway in Tenerife. In this accident, a KLM flight taking off in heavy fog, crashed into the top of a Pan Am aircraft that was taxiing down the runway in the opposite direction. In Captain Bragg's words, "we saw the KLM airplane; it didn't surprise us too much, because we were aware that he was down there. And the first thing that got my attention was that his landing lights were on." He later stated that they couldn't tell that the aircraft was moving toward them until it came closer and they saw the landing lights jiggle (Bragg, 2009).

No cost Risk Mitigation Strategy – Lights on for Takeoff

For the reasons discussed above, the consensus of the user group convened by the Office of Runway Safety was that when holding in position (lined up) for takeoff, the landing lights should be off until take-off clearance is received. Based on this recommendation, the Office of Flight Standards added the following recommendation to the air carrier Standard Operating :When holding in position for takeoff, the landing lights should be off until take-off clearance is received; in this way, it provides an indication to ATC and other aircraft that the aircraft is rolling. As is stated in the AC, "The SOP of turning on landing lights when take-off clearance is received is a signal to other pilots, ATC, and ground personnel that the aircraft is moving down the runway for takeoff." All exterior lights, including the landing lights are also to be turned on when crossing a runway.

Since the implementation of this procedure, the incidence of serious ("A" and "B") runway incursions resulting from crossing in front of a takeoff has decreased over 20%. For FY2000 – 2012, the percentage of "A" and "B" level incursions involving crossings and potential crossings in front of a takeoff was 47%. This decreased to 26% in 2004 and has remained at that level or lower through FY2008. In addition to instances in which pilots who had been cleared to cross the runway stopped upon seeing the onset of the landing light of an aircraft at the end of the runway, there have been instances in which the landing light onset served as a cue to the controller that the pilot was taking off on, or crossing, the runway. While the FAA has disseminated this information to pilots, the effectiveness of this mitigation strategy lies in each pilot adhering to the procedure. It is only through 100% compliance that the "lights on" signal can maintain its integrity. Worldwide harmonization of this no-cost procedure could provide global benefit to the aviation community.

1.4.Human factors leading to runway events

Controller Error

Several studies have sought to identify types of controller errors that result in runway incursions (Bales, Gilligan and King, 1989; Steinbacher, 1991; Cardosi and Yost, 2001). Each of these studies has identified a memory lapse that is, temporarily forgetting about an aircraft, vehicle, or a runway closure.

Forgetting

Memory lapse is consistently the most common single identifiable factor in controller errors resulting in a runway incursion. Temporarily forgetting about an aircraft, vehicle, or a runway closure was associated with 22% of the OEs that resulted in runway incursions in FY2008. Forgetting about an aircraft. Several serious runway incursions have been reported as due to controllers either issuing a landing clearance after forgetting about an aircraft holding in position waiting for takeoff clearance on the same runway, or forgetting about the aircraft cleared to land and instructing an aircraft to line up on the same runway. From FY2004-2007 there were nine incursions that involved a controller forgetting about an aircraft holding on the runway, five of these were classified as an A- level severity event, and two were classified as “B”s. There were no such events in FY2008.

There was an average of nine incidents per year in which a controller forgot about a landing aircraft (or issued a clearance consistent with forgetting about a landing aircraft). Rarely do reports explicitly refer to the controller forgetting about the arrival

Mitigation Strategies for Forgetting Errors.

Contrary to some popular advertisements, there is no magic bullet for improving the capacity of human memory in healthy adults. There are, however behavioral strategies that can be used to protect against errors due to temporarily forgetting about an aircraft, runway closure, etc. Highly regimented procedures (such as position relief briefings) benefit from checklists. In the tower, however, the information that is usually forgotten is something of a temporary nature. Memory aids (such as for runway closure and temporary designation to another controller) continue to be studied and refined. Human factors training for controllers could help educate them on the behaviors and conditions that help memory (such as writing something down or repeating it) and impair memory (such as environmental distractions and temporary or abnormal situations). This type of training course is also designed to strengthen what is perhaps the most effective safety net in tower operations – controller teamwork. Effective teamwork can help to detect and correct errors before they result in incursions. In fact, the number of errors that are caught and corrected by the supervisor or a controller on another position before they result in a reportable event is unknown. Another initiative to look at the “saves” on a developing incident is the Air Traffic

Safety Action Program (ATSAP). This program is a voluntary reporting program that seeks to improve the information available on the "saves" on which mitigation strategies can be developed.

Controller Coordination Errors

Another common type of controller error, identified in 15% of the OEs in FY2008, is inadequate (i.e., erroneous or lack of) coordination among controllers. This inadequate coordination usually involved a runway crossing. At some airports (or in some configurations), the local controller is responsible for all runway crossings. In other cases, the ground controller handles the runway crossings. Coordination issues arise when a controller neglects to get the appropriate approval for a crossing, or when there is a miscommunication about the coordination, or when the controller forgets about a coordination that he/she approved.

Readback/Hearback Errors.

Verbal communications is a vital safety net in the aviation system. In response to a transmission from a controller, a pilot will often (but not always) repeat the instruction back to the controller (hence the term readback).A pilot's readback of a controller's instruction is an important safety net for catching communication errors. In general, readback errors are relatively rare, occurring in response to less than one percent of controller transmissions. However, "hearback errors" or the controller's failure to correct the readback error is a perennial factor in operational errors, both on the surface and in the air. In FY2008, readback/hearback errors were associated with 20% of the runway incursions attributed to OEs. Thirty-four percent these errors were not readback/hearback errors per se, as they did not involve a failure to correct a pilot's incorrect readback; rather, they involved a failure on the controller's part to obtain a readback of a "hold short" instruction.

Detection and Correction of Controller Error.

In addition to identifying what goes wrong in the system, it is equally important to identify what goes right. Unfortunately, information on how errors are caught before they result in incursions is not yet available. However, an examination of how errors that result in incursions are caught and corrected is helpful in identifying needed refinements of today’s mitigation strategies.

At equipped airports, errors that results in a runway incursion may or may not be detected by automated systems such as Airport Movement Area Safety System (AMASS) or Aircraft Surface Detection Equipment Model X (ASDE-X). More often, these errors are detected by the controller that issued the clearance, another controller, a pilot, or vehicle driver. Alternatively, it is possible that no one caught the error in time to change the outcome. In FY2008, 27% of the conflicts (between two aircraft or between an aircraft and vehicle) attributed to controller error, were not detected in time for pilots to take action.

One-third (35%) of these events were detected and corrected (or attempted to be corrected) by the controller that issued the clearance that resulted in the conflict. Another 8% were detected by another controller (6% by a controller on another position and 2% by an acting supervisor). Only 2% of the conflicts were detected by vehicle drivers involved. Nineteen percent of the conflicts resulting from controller error were detected by the pilot. In these cases the pilot took corrective action and/or informed the controller of a potential conflict.

Pilot Errors

Several studies have identified a “loss of situational awareness” as the most common pilot error that result in runway incursions . This categorization is quite broad and can rightly include all but communication errors. Even the more specific term, “loss of spatial awareness” can be too comprehensive to be useful. This typically refers to the pilot thinking they are at one location when they are actually at another. However, this error category can encompass everything from misjudging the proximity to the runway (and mistakenly crossing the hold short lines) to landing on the wrong runway. For that reason, errors that might be described as “loss of situational awareness” will be categorized into more specific errors here. Correct Readback Followed by Unauthorized Maneuver.

The most common type of pilot error that resulted in a runway incursion involving a conflict with an aircraft or vehicle was a correct readback of a controller instruction followed by an unauthorized maneuver. This type of pilot error was involved in 54% of all PDs resulting in runway incursions involving a conflict in FY2008. Most (83%) of these errors involved the pilot correctly reading back a “hold short” instruction. The result of approximately half (47%) of these errors in which the pilot correctly readback the hold short instruction, was that the pilot stopped before reaching the runway edge.

The reports of pilot deviations that result in runway incursions rarely include information as to why these errors occurred. In order to gain insight into the situations that result in the most common type of pilot error, that is, reading back an instruction correctly, but then initiating another action, an analysis of reports submitted to the Aviation Safety Reporting System (ASRS) was conducted. This study examined 300 ASRS reports of airport surface movement events (i.e., runway incursions and surface incidents) at the 34 busiest towered airports submitted between May 2001 and August 2002. Most (78%) of the reports were filed by a captain or first officer who was operating the aircraft under FAA Parts 121or 135 and was directly involved in the incident. Thirty-five percent of the ASRS reports involved incidents in which pilots crossed the hold short lines without authorization. This 35% mirrors the 38% frequency of pilots crossing the hold short without authorization in the runway incursion data. Among the ASRS reports where a pilot crossed the hold short lines without authorization, more than 40% of the pilots reported a loss of “position awareness”; that is, they intended to hold short, and crossed the hold short lines without realizing it. In such cases, crossing the hold short lines without authorization was most often related to the pilot performing heads-down tasks. In fact, in 26% of these ASRS incidents, the pilot reported being heads down in the cockpit performing either checklists or programming flight deck systems as they crossed the hold short lines.

In one-third of the ASRS reports involving a pilot erroneously crossing the hold short lines, either expectations or force of habit was mentioned as a contributing factor. Pilots frequently mentioned that either the hold lines were not where they expected them to be or that they were accustomed to taking a certain route to the assigned runway (and thus holding at a different location than instructed). In these cases, when the instructions were different from what was expected, pilots unintentionally reverted to what they had done in the past. In addition, some pilots reported simply following the aircraft in front of them across the hold lines, even though they intended to hold short.

This analysis of ASRS reports showed that loss of position awareness is also the number one factor involved in pilots entering and crossing a runway without authorization. Again, the analysis of ASRS reports revealed that the most common contributing factor to these types of errors was the pilot being heads down. One-third of the pilots who reported crossing or entering the runway without authorization reported that one of the pilots was head-down at the time of the incident, most often conducting a checklist.

Another coincident factor to crossing the runway without authorization was the use of “taxi to” instructions. Pilots did not report any confusion regarding the intent of the “taxi to” instruction, but an error in position awareness, combined with the implicit clearance to cross intervening runways, resulted in the pilot crossing a runway without a clearance. For example, in some cases pilots took a wrong turn and ended up crossing a runway that they wouldn’t have crossed if they had taken the correct route. In other cases, the aircraft was not where the controller thought that the aircraft was. The instruction to “taxi to” implied a clearance to cross a runway that the controller did not intend the aircraft to cross. Changes to this procedure, such as requiring that clearances to cross all active runways be explicitly stated, are currently being considered within the Safety Management System process. ASRS reports reveal a very different type of pilot error in the cases in which an aircraft enters the runway without clearance and holds in position awaiting authorization for takeoff. This type of error was almost always attributed to communication errors. Ninety-four percent of these reports cited communication issues as directly contributing to the incident. The most commonly cited communication factors were readback/hearback errors, accepting another aircraft’s clearance, frequency congestion, and blocked communications.

Positional Errors.

In FY2008, 14% of all incursions attributed to pilot deviations were due to pilots missing a turn, taking a wrong turn, misidentifying their position on the airport surface to the controller, or making other errors involving spatial position on the ground. This does not include taking off from, or landing on, the wrong runway. A pilot is much more likely to land on a wrong runway than to takeoff on a wrong runway, In FY2008, there were 12 instances of the pilot taking off from the wrong runway (11 of them were General Aviation pilots). There were 29 instances in which the pilot landed on the wrong runway. (In one additional incursion, it was clear that the pilot would have landed on the wrong runway if the controller had not noticed that the pilot was lined up for the wrong parallel and sent the aircraft around.) There are clear patterns to this type of error. While the majority (70%) involved general aviation pilots, air carrier pilot are also vulnerable. In two cases (one GA, one air carrier), the pilot landed on the same runway (pavement), wrong direction. By far, the more common error, involved in 83% of all instances of pilots landing on the wrong runway, involves landing on a runway that was parallel to the runway referenced in the clearance.

A similar error pattern is evident in incidents involving pilots landing on taxiways. While these events do not meet the definition of runway incursion, they can involve a risk of collision. In FY2008, there were 18 instances of pilots landing on taxiways. All but one of these instances involved GA pilots. One of these reports did not specify the taxiway on which the landing occurred. In the vast majority of the remainder (76%), the pilot landed on a taxiway parallel to the assigned runway. In all but one case, the assigned runway was a parallel with a "Left"or "Right" designator. These errors fell into two patterns. One common error is that pilots landed on the taxiway to the "left" or "right" of the assigned runway with the "left" or "right" designation, respectively (e.g., landed on taxiway P which is to the left of the assigned runway 27L). The most common error pattern occurred at airports with one runway significantly longer than the other. In these cases, pilots were cleared to land on the shorter parallel and landed on the taxiway parallel to the longer runway. That is, they mistakenly view the longer runway and its taxiway as the L/R pair of runways. An example is a pilot cleared to land on the shorter parallel, 9L and landing on taxiway Papa, which is to the left of the longer runway 9R. Landing on taxiways is often a localized problem. Of these events in FY2008, five occurred at a single airport.

Error Detection

In FY2008, only 14% of the conflicts occurred as a result of pilot error (PDs) went undetected until after the event was over. Most (75%) were detected by the controller who had issued the clearance that was deviated. Five percent of these events were detected by the pilots who made the errors and an additional 5% were detected by other pilots. Two percent were detected by automation (e.g., AMASS). In the remainder of the events (2%), there was insufficient information in the report to determine who detected the conflict.

Error Mitigation Strategies

Coincident with this study was the implementation of enhanced surface markings. This included making the hold short lines more distinct (by painting a black background behind the yellow lines) and highlighting the centerline leading up to the hold short lines to provide an additional cue to pilots that they are approaching an entrance to a runway. This should help pilots avoid the error of crossing the hold short lines when they intend to hold short (although it is too early to look for a correlation in the data).

Other planned mitigation strategies include cockpit surface moving maps and continued educational and awareness campaigns. Given the distinct difference in the pattern of errors found involving GA and non-GA (Part 121, Part 135, and military) pilots, an opportunity to reduce the number of incursions with reinforcement of basic communication skills within the GA community is warranted. In addition, during flight training, the term “ground school” typically refers to the initial instruction that takes place in a classroom, rather than in the aircraft. The number of runway incursions attributed to GA pilots demonstrates a need for better education in surface operations in both initial training “ground school" and in the annual "check-ride". Finally, all pilots should continue to be encouraged to minimize heads-down time while taxiing, particularly when approaching a runway.

Vehicle Driver Errors

In FY2008, there were 52 reports of runway incursions that involved a conflict with an aircraft that were caused by vehicles or pedestrians. While a small percentage of these are due to unauthorized pedestrians on the airport surface, the majority (79%) involve vehicles. In half of these incursions involving a conflict with an aircraft (and 51% of all incursions caused by vehicle drivers), the driver never contacted air traffic control. The vast majority of vehicles involved in conflicts are not rogue vehicles, but rather, are authorized to operate on the airport surface. While there are occasional reports of privately owned vehicles (as well as bicycles and golf carts)causing these incursions, most involve airport vehicles, maintenance taxis, construction and emergency response vehicles.

Error Detection

In FY 2008, there were 206 runway incursions caused by vehicles or pedestrians. Fifty-two of these incursions involved a conflict with an aircraft. Approximately half (48%) of these conflicts were first detected by an air traffic controller. One-quarter (25%) were detected by the pilot involved. Four percent were detected by a vehicle driver and 12% went undetected until the event was over.

Error Mitigation Strategies

One of the error mitigation strategies that the Office of Runway Safety has initiated is to improve training provided to airport vehicle drivers. As part of this effort, a series of studies on the use of simulators to train airport vehicle drivers has been conducted. The first study demonstrated clear benefits for such training, using a high-fidelity simulator (Chase and Hannon, 2006). The second study sought to determine whether the same benefits could be attained with a lower-cost simulator (Chase, 2006). Recent efforts detailed the hardware, software, and resources required for an airport to build their own customized low-cost simulator

Equipment

AMASS. The reports of runway incursions rarely cite the influence or effectiveness of mitigation strategies. The exception to this involves the AMASS system. First billed erroneously as a “runway incursion prevention” device, it was later, and more correctly, described as a device to help prevent collisions arising from runway incursions. AMASS gives the air traffic controller an alert in many, but not all, conditions that result from incursions involving a single runway that could result in a collision. (AMASS logic is in the process of being revised in order to recognize conflicts between aircraft operating on intersecting runways).All alerting systems must find the ideal operational balance between legitimate alerts and false alarms. In order to be able to alert in all situations that could result in collisions, the false alarm rate would be so high that controllers would end up ignoring or “tuning out” legitimate alerts. To avoid this “crying wolf” syndrome from occurring, parameters are set so that the system alerts to most, but not all, situations that could result in a collision. From FY2002 – 2008, there were 165 reports of runway incursions that mentioned an AMASS alarm. (An alarm was assumed to have occurred if the narrative stated that “the event met the parameters in AMASS to trigger an alarm”.) These reports were examined to glean information regarding the interaction between the timing of the AMASS alerts and pilot and controller actions. In 30 events, it is clear that the controller took corrective action, but the information on the AMASS alert is unclear (i.e., “This event met the parameters configured within AMASS to trigger an alarm.”)

The remainder of the reports fell into several categories. The event was classified as an “AMASS save” if the narrative stated that AMASS alarmed and an instruction was given, unless the circumstances were such that the pilot could not comply with the instruction or the instruction

2.1. Preventative risk controls – flight crew awareness and runway design.

The need to prevent runway excursions has led to the development of a number of safeguards to help minimise the likelihood of runway excursion accidents, and help reduce the consequences of excursions that do occur through minimising the speed at which aircraft exit the runway surface in cases when aircraft do overrun. These preventative risk controls are the most important defence mechanisms against runway excursion accidents. Airline operators, flight crew, aviation safety regulators, and airport operators all have a role to play in implementing these risk controls.

The role of the airline and flight crew For flight crew and airline operators, this chapter will discuss the importance of:

• Effective standard operating procedures – conducting threat and risk briefings prior to landing, reinforcing safe approach and landing techniques (including stabilised approaches), guidance on correct use of braking devices, and a firm 'safety first' operator policy on missed approaches and go-arounds.

• Effective flight crew training and risk awareness – dangers of unstabilised approaches, factors that increase the likelihood of a runway overrun or veer-off, identifying and managing safety risks, simulator training of missed approach and go-around procedures.

• Good operator risk awareness – 'safety first' focused review of policies affecting flight crew and maintenance personnel.

Improving awareness of the dangers, frequency and contributing factors behind runway excursions through preventative risk controls, will reduce the likelihood of excursion accidents occurring. The aim of preventative safeguards is to assist flight crew to anticipatesafety risks, recogniserisks when they occur, and recover from these risks to ensure a safe outcome. The first report in this series looked in detail at what safety risks contribute to both runway overruns and veer-offs, and their prevalence in 120 runway excursions on landing worldwide between 1998 and 2007. The international aviation community is working to increase awareness of runway excursions, address the factors that contribute to them, and develop physical measures to reduce the consequences of excursion accidents that do happen. The Runway Safety Initiative (RSI) is a wider, international effort to improve runway excursion awareness, and is coordinated by the Flight Safety Foundation (FSF). A major task of the RSI is to support and promote existing and ongoing programs by governments, operators, and safety organisations to prevent runway incursions and excursions. One suchprogram is the FSF Approach and Landing Accident Reduction (ALAR) Task Force, which has developed a series of briefing notes and risk identification and reduction tools aimed at instilling safer flight crew behaviours and clearly identifying safety risks that exist during the approach and landing phases of flight. The FSF ALAR Task Force identified some ofthe key preventative risk controls that will control the flight crew performance, technique and decision, weather, and systems-related factors that contribute to runway excursion accidents

- A strong operator policy on stabilised approaches, with commitment from all levels of the organisation.
- A focus on establishing stable approach criteria as early as possible.
- Effective monitoring and challenging of approaches by other members of the flight crew.
- A willingness to say ‘no’ to air traffic control (ATC), where the flight crew considers their instructions are unsafe.
- Zero tolerance of deviations from the operator’s SOPs.
- Promotion of the use of precision approach and landings, such as instrument landing systems (ILS). A British study of 180 turbine-powered aircraft overruns between 1980 and 1998 found that the likelihood of an overrun following a precision approach was three times less than for other types of approaches .
- Careful monitoring of performance during visual approaches, and nonprecision approaches, such as non-directional beacon (NDB), very high frequency omni-directional range (VOR), and area navigation global navigation satellite system (RNAV(GNSS)) approaches. For preventative risk controls to provide their full safety benefit, dedicated approach and landing risk training and good flight crew

awareness of the implications of runway accidents are needed. The RSI intends to do its part in this effort through ongoing development of its Global Plan for the Prevention and Mitigation of Runway Excursions. This document, when completed in 2009, will consist of 20 to 30 briefing notes and supporting data on these and other preventative risk controls, and a discussion of the contribution that constant-angle non-precision approaches, precision, and precision-like approaches can make towards achieving and maintaining a stabilised approach The role of the airport and the regulator For airport operators, and aviation safety regulators, this chapter will discuss the importance of the following.

• Quality runway design – regular inspection, maintenance and treatment of runway surfaces, friction coatings and bearing strength, and improvement of surfaces though runway grooving or surface texturing.

• Accurate runway condition reporting – greater cooperation between the International Civil Aviation Organization (ICAO) and state civil aviation authorities to develop standards for reporting runway condition information.

• Aiding flight crew awareness of available runway length through runway distance remaining signs (RDRS) installed at regular intervals along the runway edge.

• Runway edge and centreline lighting. Maintaining good runway friction is the most important preventative risk control that airport operators can put in place to reduce the likelihood of a runway excursion. Inspection and repair of depressions and cracks in the runway surface, and texturing of the runway surface though use of a bask brush/broom or dragged burlap (for concrete runway surfaces), or chip and aggregate slurry seals (for temporary use on asphalt runway surfaces)improves the friction of pavement surfaces (Runway grooving is another simple, cost-effective and proven method to drain surface water and improve friction, and in most periods of heavy rain is able to prevent standing water accumulation that can lead to aquaplaning. Grooving and other surface texture treatments are in widespread use at airports in the world. The FSFs Global Plan for the Prevention and Mitigation of Runway Excursions will also direct airport operators via briefing notes on the types and roles of various recovery risk controls that can be used to control a runway excursion if one occurs (such as runway end safety areas and soft ground arrestor beds). Recovery risk controls are discussed . The FSF Plan will also highlight the importance of runway lighting, marking, and signage in assisting flight crews to maintain spatial awareness during approach and landing.

Effective standard operating procedures (SOPs)

Well-developed operator SOPs are an important preventative risk control to mitigate runway excursions. A detailed study of 76 approach and landing occurrences by the FSF ALAR Task Force in 1998 found that 74 per cent involved poor professional judgement or airmanship, and 72 per cent involved a flight crew omission or inappropriate action. Deliberate non-adherence to SOPs was a contributing factor in 40 per cent of occurrences (Khatwa & Helmreich, 1999). An analysis of 120 runway excursion accidents on landing between 1998 and 2007 from the Ascend World Aircraft Accident Summary, presented in the first report in this series (Taylor et al, 2009), found that a lack of awareness and compliance with SOPs was the leading flight crew performance factor that contributed to worldwide runway excursions. Also contributing significantly were SOPs that were less than adequate in terms of providing guidance to the flight crew for safe approach and landing techniques in typical weather, runway, and operational conditions. In total,SOP quality and compliance issues contributed to 16 accidents (13 per cent).

Non-compliance with SOPs can be reduced by ensuring they are relevant, provide adequate guidance (and any appropriate limitations) for operating in a range of weather conditions and aircraft configurations, and above all, be focused on the end user - the flight crew.. In the 1970s, the Australian regulator (Department ofCivil Aviation, now CASA) issued a safety directive to airport operators not to use wire brooms on runway surfaces, as the wires could let go from the broom and cause a tyre puncture or other foreign object damage. Of the 76 occurrences studied by the FSF, runway excursions were the second most common type of approach and landing accident (20 per cent), after controlled flight into terrain (37 per cent). Unstabilised approaches made up a further eight per cent of occurrences.

a minimum, operator SOPs should contain the following procedures directly related to runway excursion prevention:

- a requirement to fly stabilised approaches, including procedures for executing a go-around if the approach parameters are outside of the stabilised approach criteria;
- a requirement to conduct a landing distance reassessment at the time of arrival; and
- guidance on the correct use of brakes and other deceleration devices in different runway conditions.

Conducting pre-landing risk and threat briefings A pre-landing risk and threat briefing can assist flight crew in assessing whether a landing attempt is safe in the prevailing weather and runway conditions, and provide a conservative estimate of landing rollout length prior to arrival that takes these conditions into account. Flight crews should conduct a pre-landing risk and threat briefing. The FSF has recommended that this briefing should take the following factors into consideration, based on the aircraft configuration and the runway condition:

- prevailing weather conditions (winds and gusts, wind shear etc.);
- runway conditions (water-affected, contaminated etc.);
- actual weight of the aircraft upon arrival, especially if fuel burn en route was higher or lower than normal;
- use of braking devices during the landing roll (autobrakes, reverse thrust etc.);
- airport elevation and runway slope; and
- minimum equipment list (MEL) items and dispatch deviation guide (DDG) conditions, or in-flight system failures (if any) (FSF, 2000b).

The pre-landing risk and threat briefing should also identify if conditions exist that might make a landing unsafe. The FSF recommends that SOPs require a diversion to an alternate airport where the runway conditions are more suitable, if:

- the runway is known to be contaminated or is affected by standing water;
- prevailing cross and tailwinds are beyond limits; or
- only one thrust reverser is operational, oran anti-skid system is not fitted to

the aircraft (if the runway is wet) .

It is important for flight crews to remember that published landing lengths in aircraft flight manuals (AFMs) are based on flight test conditions, and are not accurate for most real-world operations. It is important for SOPs to provide specific landing distance factors for different operational conditions, and provide guidance so that flight crew know when and how to apply them to the dry runway landing distance published in the AFM. The FAA and European Joint Aviation Authorities (JAA) require a minimum factorof 1.67 to be applied to landing distance in dry conditions, and 1.92 in wet conditions .

Timely and effective braking

Timely and effective use of braking devices is critical in decelerating the aircraft in the minimum possible runway length. Analysis of the Ascend World Aircraft Accident Summary in the first report in this series, found that of the 120 runway excursions that occurred on landing between 1998 and 2007, almost a third (n = 36) involved some form of delayed or incorrect use of braking devices by the flight crew, or inadequate identification of and response to a failure in the aircraft braking system.

Recommended that standard operating procedures should require the following actions from flight crew during the landing rollout.

- Monitor and call extension of the ground spoilers immediately after touchdown – they are most effective in increasing drag at high speeds.
- Select maximum reverse thrust as soon as possible – this provides the maximum possible deceleration force at high speed.
- Monitor ground speed throughout landing roll, and reduce engines to idle reverse at the required speed (as per the AFM).
- Monitor the autobrakes to ensure the aircraft is decelerating as expected - use steady pedal braking to stop aircraft if necessary.
- Apply manual braking effectively – heavy braking at high speeds is ineffective, as it increases the likelihood of both aquaplaning and tyre blowout

Enhanced flight crew training and risk awareness

An effective training program is another preventative risk control that provides flight crews with an operationally-focused knowledge of factors that affect landing performance. Practical training, such as the use of flight simulators, reinforces the practical application of approach and landing SOPs in the cockpit. To improve awareness and knowledge of approach and landing safety, the FAA recommends that operators' training programs should include:

- coverage of operator-specific approach and landing SOPs;
- stabilised approaches, and stabilised approach criteria;
- good CRM principles, and their importance in preventing flight crew error and delayed flight crew actions;
- the source, and appropriate use of landing distance data contained in aircraft flight manuals (AFMs);
- calculation of required landing distance prior to arrival;
- the need to reassess landing distance calculations at the time of arrival (CASA (2002) a has indicated that CASR Part 121 will require that this be done 30 minutes prior to landing);
- consequences of excess airspeedon landing rollout length;
- consequences of long landings beyond the intended touchdown point;
- tail and crosswind limits specific to the operator's aircraft types, and the consequences of conducting a landing outside those limits;
- correct use of braking devices specificto the operator's aircraft types (autobrakes, ground spoilers, thrust reversers);
- the importance of being aware of inoperative equipment and systems on the MEL or DDG that might affect landing length;
- 'rules of thumb' to calculating required landing distance (such as the FAA '70 per cent' rule); and
- reasons to initiate a go-around, and howto execute a go-around. A policy of 'no-blame' for go-arounds should be reinforced throughout training .

These principles can be reinforced by line oriented flight training (LOFT), where pilots can fly approach and landing profiles in a simulator that provide a practical appreciation of the consequences of flight crew decisions (such as flying an unstabilised approach), and their relationship to runway excursion accidents. In these LOFT sessions, instructors are able to demonstrate the indicators that were the precursors to the accident, so that pilots can recognise when a go-around is required. This is a similar model to the successful microburst and wind shear simulator training that has been commonplace in the airline industry since the 1980s.

The cost of no action

Air transport supports nearly 57 million jobs around the world and $2.2 trillion in global economic activity. If it were a country, the aviation sector alone would be the 19th largest economy in the world, around the same size as Switzerland. The trade that aviation supports is valuable and the jobs the sector provides are 3.5 times more productive than average jobs in the economy. It is worthwhile to note that the areas of economic growth that aviation helps drive – high-tech manufacturing, high-value produce and service industries such as tourism – are areas that will continue to provide the stimulus for economic development around the world.In a recent study for the Air Transport Action Group, Oxford Economics forecast that by 2030, over 82 million jobs and $6.9 trillion in economic activity would be supported by air transport, based on current growth rates. A lot of that growth is taking place in the emerging markets and developing economies of the world. But the growth is not guaranteed. While forecasting such long-term trends is difficult, Oxford Economics undertook a sensitivity analysis of future growth in passenger and cargo traffic. For example, should growth in passenger and cargo traffic be just one percentage point lower during the period 2010-2030, then in 2030:

- The total number of jobs supported bythe air transport sector would be over 14 million lower than the base forecasts.

• The direct,indirect and inducedcontribution of the air transport sector to world GDP would be $646 billion (2010 prices) lower, with an additional $542 billion lost through lower tourism activity.While airlines are notoriously susceptible to financial constraints impacting their growth (and bottom line), the lack of capacity in the air traffic management system could impede air traffic growth and its knock-on benefits to the global economy.

Capacity improvements Air transport and its importance to modern life is growing. From today's 26 million commercial aircraft movements, it is expected that by 2030 the number of flights will almost double to 48.7 million. In addition, there are general aviation and military movements to consider. Passengers will also be travelling further. In 2010, over 4.8 trillion passenger kilometres were flown by airlines (one passenger flying one kilometre is a 'passenger kilometre'). By 2030, forecasts suggest that 13.5 trillion passenger kilometres will be flown. But the airspace is not getting any bigger and there will not be a huge number of airports built to accommodate this growth, so the system must increase its efficiency to deal with the challenge.

In Europe and North America, congestion has already been causing constraints to growth for a number of years. One of the causes is the need to keep aircraft at sufficiently safe distances from one another due to the lack of accuracy of legacy air navigation technology. The system is very safe, but it is not as efficient as it could be. The impact of congestion is likely to be repeated in developing economies a their air transport industry grows to meet the demands of burgeoning middle class travellers. The effects are already being felt in the airspace over the Gulf States and the Pearl River Delta. However, a number of these rapidly-developing air transport markets should be able to make the most of early access to new technology, enabling them to see the benefits of more advanced airspace management without having to suffer the economic impact of congested airspace.

Unlike the improvement projects in the United States or Europe, within Asia there is no overarching legislative framework to operate within and drive change.

There is, however, a clear vision for a Seamless Asian Sky emerging. This foresees not a single sky as in Europe, but a system of information exchange and coordination between air navigation service providers, which would allow for far greater efficiency. This is particularly critical in a rapidly growing market such as Asia, where a failure to stay in front of the capacity curve will directly impede growth and economic expansion.Capacity planning on the ground is also a crucial part of the system. Runways and airport congestion can lead to delays in the air as well as on the ground and sufficient planning for new infrastructure is vital. China is leading the way, with 82 airports scheduled for construction between 2011 and 2015 alone. Fewer delays, less lost time, benefiting the entire economyAccording to GE Aviation, if a certain landing technique, called required navigation performance or RNP (see page 10), were deployed immediately at 46 mid-size regional airports across the USA, airlines (and, more importantly, passengers) would benefit from 747 fewer days' worth of flying unnecessarily long landing approaches. In one of the most congested pieces of airspace in the world, the Greater New York area, the total value of the lost time absorbed by the travelling public due to air traffic congestion was estimated to be worth $1.7 billion in 2008 alone3. When adding the losses in fuel and staffing costs borne by the airlines, as well as the delays to shipping companies, over $2.6 billion in lost economic activity occurs in one year alone. The Partnership for New York City has projected that the cost of congestion will total some $79 billion between 2008 and 2025. In addition to the losses incurred by those using the system, it is estimated that the knock-on effects on other parts of the economy will result in 5,600 fewer fulltime jobs and $16 billion in lost output over the 18 year period.That was in one metropolitan region. An FAA-sponsored study in 2010 on the impact of air traffic delays across the USA found that in 2007, there was a $32.9 billion cost related to congested airspace, of which $4 billion was in lost economic activity to the wider US economy.

In fact, in a 2011 study looking at the benefits of introducing next-generation air traffic management systems around the world, Deloitte found that of the $135 billion annual benefit of moving to better air traffic systems, 30% accrued to the 'overall economy' (with airlines benefiting from 31% of the savings, air navigation service providers (ANSPs) 5% and passengers 34%).In Europe, too, the Single European Sky is expected to lead to significant and widespread benefits for the European community. The current, fragmented, operation of the European airspace leads to an estimated €5 billion additional cost to airspace users per annum, as well as around 100 million hours of delay to passengers and 8.1 million tonnes of additional CO2. Members of the European Parliament voted in favour of a resolution in October 2012 that highlighted, if there is a 'full and timely deployment' of the SESAR technology for the Single European Sky, "there could be a cumulative impact on [European Union] GDP of €419 billion during the period 2013-2030… with 328,000 jobs being created directly or indirectly and a net saving in CO2emissions of some 50 million tonnes". Environmental benefits It is a clear objective of the aviation industry to reduce its environmental impact. Through the United Nations Framework Convention on Climate Change and the International Civil Aviation Organization (ICAO), governments around the world have committed to reduce carbon dioxide emissions from human activities – and in aviation, there is a direct correlation between saving fuel and reducing emissions. In 2009, the aviation industry agreed a set of ambitious targets to reduce carbon dioxide emissions as part of its commitment to action on climate change. Even though the air transport sector produces 2% of man-made CO2, it is a rapidly growing industry that recognises that the threat of climate change must be confronted by all industries.

Fuel is also the largest operating cost of airlines, currently totalling over 30%. These two incentives – to reduce CO2emissions and reduce fuel consumption – have led to a series of aggressive crossindustry targets. These have gained quick recognition throughout the industry and beyond: 1. To improve fleet fuel efficiency by 1.5% per annum between 2009 and 2020.2. To stabilise net CO2emissions from aviation from 2020 through carbonneutral growth3. To reduce net CO2emissions from aviation by half by 2050, as compared with 2005The industry is embarking on a four-pillar strategy to achieve these targets through new

Expected savings per year if air traffic management systems and technology on board aircraft were optimised

technology (including the deployment of sustainable aviation biofuels), operational improvements, infrastructure efficiency gains and appropriate market-based measures. There are collaborative projects underway throughout the industry, some of which are outlined in this report, that are helping to meet these targets. However, meeting these targets also requires governments to do their part – through air traffic management improvements and technology and operational measures under their control.While it will take all available efforts to achieve these goals, it is a waste to have very efficient aircraft technology if the aircraft is then

Global air traffic has doubled in size once every 15 years since 1977 and will continue to do so. This growth occurs despite broader recessionary cycles and helps illustrate how aviation investment can be a key factor supporting economic recovery.

forced to hold above overcrowded airports or fly circuitous routes because of congestion.

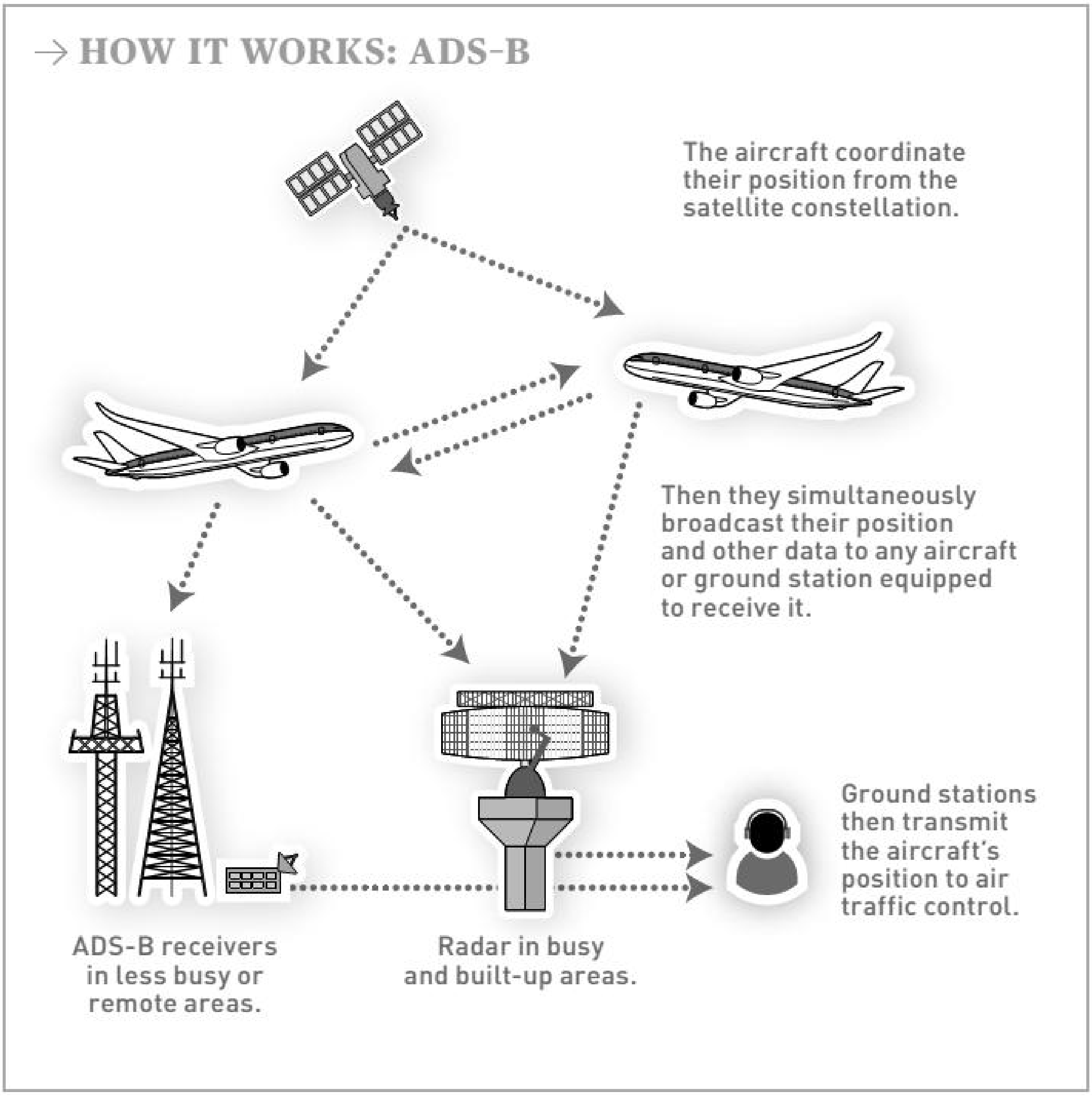
The environmental benefits of shifting towards a more efficient air traffic system are significant. In Europe, by implementing the Single European Sky, average fuel consumption per flight could be reduced by up to 10%. And, despite the additional flights that will use the system as capacity constraints are reduced, it is thought that between 2013 and 2030, projects implemented by the SESAR technical programme to introduce the Single European Sky would save around 50 million tonnes of avoided CO2.A number of these new technologies and operational procedures can have an impact on the amount of noise experienced by airport communities too. With much more accurate navigation, flights can be routed around communities, land using steeper descents or with engines on idle to limit noise impacts for those living near airports. Cost reductions to airlinesIn 2011, over $176 billion was spent on jet fuel by the world's airlines – the number one operating cost. The GE Aviation analysis of RNP implementation at 46 regional airports in the US suggests that implementing this one technology will save airlines $65.6 million in fuel costs. In a trial implementing ADS-B systems (see page 12) along just two routes in the South China Sea, the three ANSPs involved – from Indonesia, Singapore and Vietnam – have worked together to share data and coordinate operations. A cost benefit study released by CANSO and the International Air Transport Association (IATA) indicates that by introducing the new processes on these two routes, there will be annual savings of around 1,300 tonnes of fuel (or 4,500 tonnes of CO2) with an annual cost reduction of $4 million dollars. This trial is being expanded to include two more routes and ANSPs in the Philippines and Brunei. Consolidation of the air traffic control infrastructure can also lead to reductions of the user fees that airlines pay for air navigation services. Europe’s 37 ANSPs operate around 65 area control centres (ACCs) each duplicating the task of its neighbour. By contrast, over an area roughly the same size, the US has 20 ACCs, which it is working to consolidate. Russia’s plans are more impressive; it is consolidating its centres from 118 to 13 over an even larger area.

Harmonization in action

ADS-B is certified as a viable, lower-cost replacement for conventional radar and tracks aircraft in non-radar airspace. With ADS-B, air traffic controllers can monitor and control aircraft with greater precision and over a far larger percentage of the earth’s surface than has ever been possible. For example, large expanses of Australia, Gulf of Mexico, and Hudson Bay in Canada, previously without any radar coverage, are now visible on air traffic controller screens. ADS-B is a result of the collaboration of regulators, ANSPs, aircraft manufacturers, airlines, avionics and ground system providers.

What is it?

ADS-B brings together satellite navigation systems and a network of on-the-ground receivers to ensure much broader surveillance of aircraft positions. The radar stations used currently in many places are very expensive and are, therefore, restricted to the regular traffic areas. Other locations (such as over oceans and in the middle of sparsely populated areas), have very strict operating restrictions because there is no surveillance. With ADS-B, the network of global positioning system satellites is used in conjunction with less costly receivers (almost like cell-phone towers), located across the ground. The technology also allows for more dependable surveillance of aircraft positions, as it allows for continuous monitoring of aircraft location, as opposed to radar which detects aircraft only when the system sweeps the area. Owing to the much greater confidence in monitoring, the separation between aircraft can be reduced, allowing more efficient



routes and greater airspace capacity. The United States Federal Aviation Administration (FAA), Nav Canada, Air Transport Canada, Australia's Civil Aviation Safety Authority, Airservices Australia, and Eurocontrol have been jointly working to develop and deploy ADS-B based surveillance services. This collaborative effort has paved the way to harmonising both ADS-B system approaches used in each of the regions and equipment on international aircraft. These groups have also rallied behind developing common ADS-B standards. In December of 2009, a common set of ADS-B minimum operation performance standards were published simultaneously in many countries.

Flexible routing saves fuel

Over 90% of today's aircraft could fly more flexible 'direct' routes from departure to destination – routes that are free of pre-defined air route structures and free to take advantage of beneficial winds. This capability is well demonstrated in the International Air Transport Association's (IATA) iFlex project. For years, aircraft have navigated from their point of departure to their destination along highways in the sky, defined by a series of radio beacons linked into a network.

For years, aircraft have navigated from their point of departure to their destination along highways in the sky, defined by a series of radio beacons linked into a network. This network, while useful and convenient, is based on ground systems providing navigation and does not ordinarily lead to short, efficient routes. Today's aircraft with space-based GPS can fly safely to their destination without reference to ground navigation aids or airways. If an aircraft could plan and fly a 'flexible route' which is the shortest feasible, wind-adjusted route, then significant fuel savings are possible. Over 90% of aircraft today could fly a flexible route that takes full advantage of the wind, but fewer than 10% actually do. Just as personal computers and personal GPS systems are now able to calculate the fastest or most fuel-efficient route to our driving destinations, airline flight planning computers and aircraft satellite-based navigation systems can do the same for air travel. Airlines invest heavily in modern aircraft navigation and flight planning systems but their abilities to leverage these capabilities into operating cost advantages are hindered in regions where flights are required to conform to the legacy network of fixed routes. It is, therefore, essential for air navigation service providers to work collaboratively with their customers towards the goal of flexible use of airspace.

Flexibility is derived from the design of the airspace. Opportunities for flexibility exist in almost all operating environments, whether in high or low traffic density by allowing and employing flight routings that optimise trajectories considering winds aloft.

Since today's aircraft can spend hours in the air, their total fuel burn is naturally sensitive to the winds at attitude. These winds, often over 100 knots (185 kph), can be a headwind, a crosswind or most favourably, a tailwind. By reducing the impact of headwinds and finding tailwinds – even if the flight ends up flying further in distance – it can do so in less time and using less fuel.

As aircraft design has improved over the decades, so has the range. It is now a matter of routine to have flights operating routes of well over 12 hours between continents. Current maximum airliner endurance approaches 17 hours. Initial computer modelling of long-haul flights has shown a major opportunity to leverage operating benefits by using flexible routings.

Air traffic controllers are often very good at offering short-cuts to the route when they become operationally available. These short-cuts are valuable to the flight when they eliminate routing constraints that had been imposed when the flight plan was developed. However, there is an overhead cost to carry the extra fuel weight required by the original plan. The overhead for a 12 hour flight is approximately 4.7% for a Boeing 747.

There are several efforts taking place around the world to realise some of this untapped potential for savings. The Asia Pacific region is the world’s fastest growing aviation market, where commercial aircraft carried over 34% of all world passengers in 2010. Asia has replaced North America as the world’s largest market. The Seamless Asian Skies is a project whereby the multitude of flight information regions (FIRs) in the region are to harmonise their air traffic management into a seamless entity which would, in turn, lead to increased efficiencies and reduced fuel burn and emissions.IATA’s iFlex project concentrates on ultra-long-haul flights and the ability of ANSPs to offer more flexible routings. The iFlex programme builds on existing best-practices, current technology and solutions that can be implemented safely.

In 2010, the International Civil Aviation Organization (ICAO) embarked on a significant project to achieve global interoperability between now and 2030. It began by developing a framework for a systems-engineering approach to global

ATM improvements known as the aviation system Block Upgrades (BUs). The BU framework is based on specific performance capability ‘modules’ which reflect the sector-wide consensus of the latest technologies and procedures entering service from existing ATM modernisation programmes. These were added to industry-agreed projected capabilities and concepts. The block upgrades should be adopted on a global basis to deliver a seamless ATM system.Importantly, the mandate to deploy these modules is flexible and based on the specific operational needs of the State or region where they are to be implemented.

The BU modules aim to systematically improve international interoperability through a standardised set of specific ATM enhancements which:

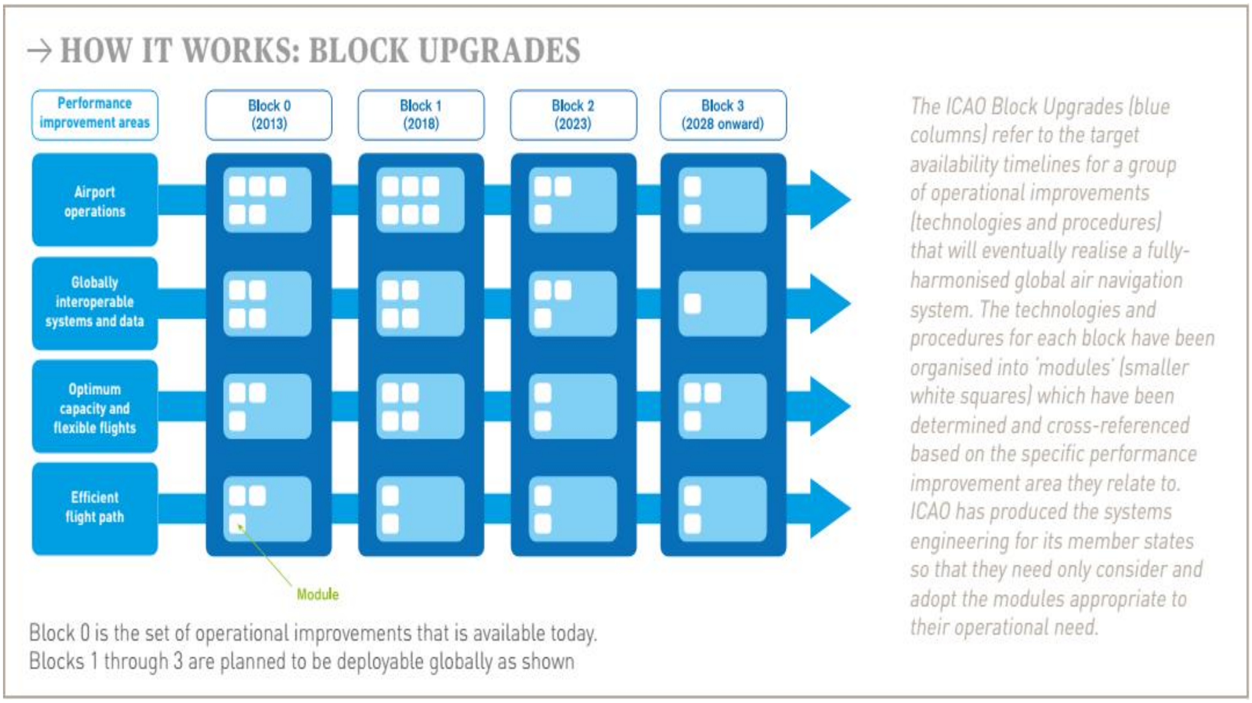
1. Provide measureable operational improvements.
2. Capitalise on existing aircraft apabilities.
3. Standardise operational procedures and certification.
4. Yield a positive business case for implementation.

These modules are not required in all airspaces, only where they offer the most benefit.Each block in the ICAO system represents a target availability timeline for the performance modules it contains. Block ‘1’ (2018), for instance, features modules characterised by operational improvements which will be available for implementation by that date. This includes the procedures, technologies, regulatory approval plans, standards and guidance material.

The modules have also been organised on a reductive basis across the blocks, decreasing in number as they realise their operational benefits and target performance capabilities.

The module specifics were developed with the assistance of the full spectrum of State and industry experts that attended the Global Air Navigation Industry Symposium. Over 500 participants attended this event, which featured critical inputs from organisations such as CANSO, ACI, IATA, the International Business Aviation Council (IBAC), the International Coordinating Council of Aerospace Industries Associations (ICCAIA) and many others.

ICAO presently estimates that funds spent on air traffic systems modernisation over the next decade, not only in Europe and the USA but also in Latin America, Russia, Japan, China, India and South-East Asia, will exceed $120 billion. Several of these States and others not mentioned here have already begun to map their air navigation planning to the Block Upgrade methodology.



Asia-Pacific is now the world's largest aviation market and home to more than half of the world's population. In 2010, the region accounted for 34% of the world's passenger traffic with annual growth rate of 6.9% projected for the period 2010 to 2015.With continued economic growth, rising incomes and populations with a greater propensity for air travel, ATM in the region must keep pace with fast rising demand for air transportation to support greater trade, tourism and investment flows.Asia-Pacific ATM challenges. The immediate challenges for ATM in the Asia-Pacific region are those associated with growth. Is the region ready to handle the projected increase in air traffic? And what are the consequences if capacity fails to keep pace?

Asia-Pacific includes a wide spectrum of ANSPs – from the most developed and efficient, to the developing. Therefore, while ATM technology to raise the level of flight safety and efficiency already exists, it is a major challenge introducing new and sophisticated technology and procedures that are interoperable while ensuring harmonised implementation by all ANSPs.

Recognising this challenge and related developments in other regions, an AsiaPacific Seamless ATM Planning Group comprising States and international organisations has been set up by ICAO recently to determine the means for seamless ATM development in the region. ICAO's recent introduction of the aviation system block upgrades was a timely development for the region as it provides a global framework for planning and ensuring that national ATM plans and their implementation are harmonised across the region. However, for the less developed ANSPs, there will be a need to also address the more fundamental issues of technical assistance, specifically the availability of funding, expertise and training.

There are other constraints faced by the ANSPs of the region that are not technological or financial. These are governance and institutional issues. Most ANSPs in the region are part of a government department or statutory authority and their ability to respond to changes in a rapidly evolving aviation landscape can be constrained.

2.2. Evolution of runway safety

The current reality of increasingly congested airspace, safety disparities between regions and, importantly, real-time news reporting of air accidents and public perception of how these accidents are handled, are some of the challenges faced by the aviation sector.

Major progress has been made recently in the area of runway safety. In 2012, there was a significant reduction in runway safety-related accidents (as defined in ICAO Annex 13), with a decrease of 21 per cent. In addition, the global accident rate involving scheduled commercial operations for 2012 decreased significantly to 3.2 accidents per million departures.While these results are favorable, runway accidents have represented the highest single occurrence category for all air accidents over the past ten years. Assembly Resolution A37-6, entitled Runway Safety, resulting from the 37th Session of the Assembly in 2010, called upon States to undertake initiatives to enhance runway safety through the establishment of a Runway Safety Programme using a collaborative approach including regulators, aircraft operators, aerodrome operators, and air navigation services providers to prevent and mitigate the effects of runway excursions, incursions and other related occurrences.

Pursuant to the Resolution, ICAO held a Global Runway Safety Symposium in 2011 and, following a commitment from 11 partner aviation organizations, Regional Runway Safety Seminars (RRSSs) were introduced. The RRSS Programme was developed to highlight such matters as hazard identification, risk assessment and mitigation strategies; the value of establishing Runway Safety Teams (RSTs); resources available for RSTs; and the regional strategy to establish, promote and provide ongoing support to RSTs. RRSSs are held regionally and are hosted by a State in cooperation with ICAO and at least one of the 12 Runway Safety Partners: ACI, CANSO, EASA, EUROCONTROL, FAA, FSF, IAOPA,IATA, IBAC, ICCAIA, IFALPA, and IFATCA.

"While acknowledging the progress made by the industry, IATA, together with its industry partners, recognizes the need for continued improvement in the area of runway safety, which is one of the industry's principal risk areas. Events such as runway excursions, runway incursions, hard landings and tail strikes are areas we still have to work on. Therefore, IATA believes that it is appropriate to address all runway safety issues in a comprehensive and collaborative manner and in this regard, we are focusing our efforts, attention and resources on working with other stakeholders including ICAO, Airports Council International and others to develop solutions to address this issue," stated Guenther Matschnigg,Senior Vice President, Safety and Flight Operations, IATA.

ICAO's overarching focus is on trying to become more preventive and predictive of occurrences and accidents, rather than waiting for something to happen and then trying to learn from investigating an event after it has taken place. "ICAO feels that the best approach to this is a multidisciplinary one whose objective is to gather together representatives from the various stakeholders in runway safety in order to promote the establishment of local runway safety teams using a proactive approach," said Nancy Graham, Director, Air Navigation Bureau at ICAO.

To date, RRSSs have been held in a number of countries around the world, with two scheduled for November this year, one in Turkey and another in Malaysia. Each Seminar is adapted to needs of the region and feedback is collected to determine what support is required. For the RRSS held in Antigua and Barbuda, for instance, general aviation issues were considered to be very important. In Morocco, some attendees expressed the need for training in how to work collectively, and in how to negotiate for the implementation of the solutions they develop with the impacted service providers.

In August 2013, ICAO introduced the Matrix Management concept to the Air Navigation Bureau, involving a transition from the use of traditional, single-discipline teams to a more flexible multidisciplinary team approach to problem solving. A matrix structure is conducive to providing the Organization greater agility in setting up projects that require resources from various sections or disciplines. Individuals involved in a matrix team have the opportunity to interact more with their colleagues in other parts of the Bureau. The objective is for flight operations, aerodrome and air traffic management experts, for example, to develop solutions together rather than separately in isolation of each other, which will benefit industry stakeholders, as well.

Matrix Management represents a cultural change in the delivery of implementation assistance that will require training as team members become accustomed to this new way of working. If the Runway Safety Programme is not implemented using a Matrix Management approach, or something similar involving multi-disciplinary collaboration between multiple internal and external entities, it won't be achieved as effectively and efficiently as it could be.

2.3. New handbook for runway safety teams

The first edition of the ICAO Runway Safety Team Handbook is being developed in conjunction with ICAO's Runway Safety Partners and a draft of the document appears on the Organization’s Runway Safety website (www.icao.int/RunwaySafety).The purpose of the Handbook is to provide guidance for Runway Safety Teams at airports. It advises them as to Runway Safety Team objectives, possible team participants and how to get set up, and it includes examples of meeting agendas and topics that should be covered. Similar to the Matrix Team concept, ideally it would involve, among other entities, airlines− which are users of the airport − air traffic controllers, aerodrome operators, and the State regulator as a member, observer or facilitator for ideas that may be put forth. Participant feedback has been extremely positive. David Gamper, Director, Safety and Technical at Airports Council International (ACI), has attended several RRSSs and is confident of its benefits. “In Africa, there were excellent interventions and speeches, with a very participative audience and a huge thirst for more information.” Gamper noticed great enthusiasm for the sharing of experiences at the various seminars. “I think that these seminars should be continued in all parts of the world and ICAO is certainly playing a key role in working with the rest of the industry,” he continued. Ms. Graham noted that the recent reduction in runway safety-related accidents is encouraging, although a direct cause-and-effect with the RRSSs cannot be established. “For now, it’s a positive sign and we need to keep moving in that same direction and see if we can maintain those same results over a more significant period,” she stated.

Planning your aerodrome operation

Thorough knowledge of your aerodrome is essential for safe driving. Take a moment to think about where you need to go and how you are going to get there. ƒ Have a current aerodrome chart or diagram readily available to use. ƒ Check the expected route against the aerodrome chart or diagram and pay special attention to any complex intersections (for example, where two or more taxiways cross) or where you will be close to a runway.ƒ Always be aware of where you are and what is around your vehicle — especially when operating close to a runway.

ƒ If in doubt of your current position on a taxiway, ask air traffic control (ATC) for assistance.ƒ If in doubt of your position on an apron, ask for assistance from other ground personnel (for example the aerodrome safety officer).Movement Area Guidance Sign (MAGS): You are at the Holding point for Runway 34-16 on Taxiway E with 2345m take-off run available on Runway 16.

Aerodrome procedures

Following good operating procedures increases the safety of operations on an aerodrome. This section focuses on some of the common tasks that you should incorporate into your driving habits.

Air Traffic Control (ATC) Instructions

Drivers of vehicles must obtain an ATC clearance and instructions before entering the manoeuvring area (any taxiway or runway).Once you receive an ATC clearance or instruction, you should:

- Write down the clearance or instruction, especially where they are complex. This can help reduce the chance of forgetting part of the clearance or instruction.
- Monitor ATC clearances/instructions issued to other vehicles and aircraft to help you build up a picture of what is happening around you.
- Be especially careful if another vehicle or aircraft has a similar sounding call-sign.
- Listen carefully to avoid responding to a clearance/instruction intended for someone else.
- Ask immediately if you are uncertain about any ATC clearance/instruction.
- Read back all required clearances/instructions including your vehicle call-sign.
- Remember an ATC instruction to operate on taxiways or other areas of the aerodrome is NOTa clearance to cross a runway holding position, illuminated stopbar or to enter or operate on a runway unless specifically cleared to do so.
- Only the words CROSS or ENTER authorise a vehicle on to a runway. At some aerodromes, holding positions may not be marked, in which case, vehicles should hold short of the runway strip edge usually marked by gable markers. This also applies to works vehicles operating on areas adjacent to runways where there are

no taxiways, such as mowers.

- Advise ATC if you anticipate a delay, or are unable to comply with their instructions.
- Look for light signals from the tower if you suspect radio problems.

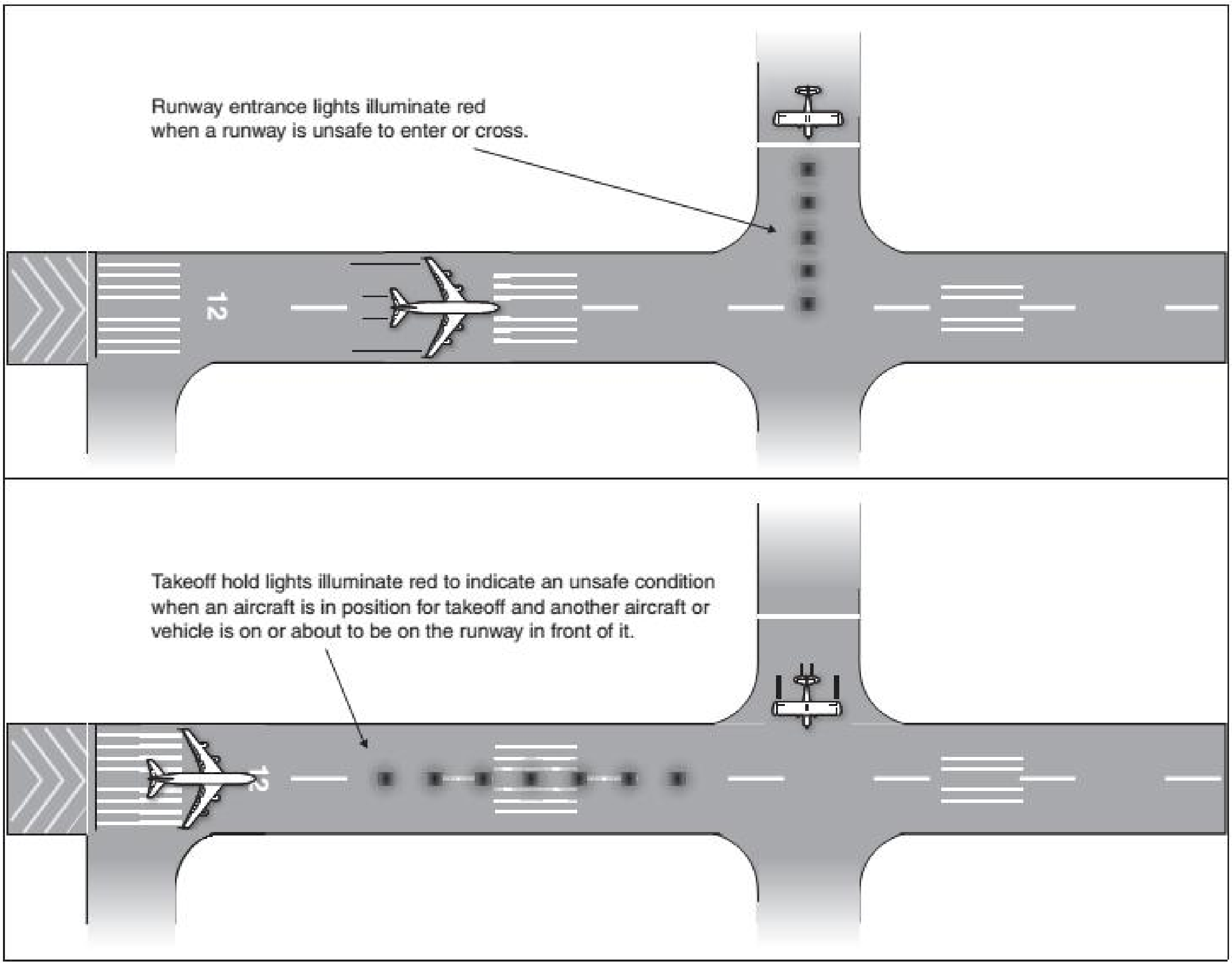
Situational awareness

When operating on the aerodrome, you need to be aware of your location, and how that location relates to your intended route, and to other vehicles and aircraft that may be operating on the aerodrome. This is commonly referred to as ‘situational awareness.’ Maintain situational awareness by:

- ensuring you understand and follow ATC instructions and clearancesƒ using a current aerodrome chart or diagram
- knowing the meaning of the visual aids available on the aerodrome, such as markings, signs, and lights
- monitoring the radio and using the aerodrome chart to assist you in locating other aircraft and vehicles that may be on the aerodrome
- maintaining a ‘sterile’ environment in your vehicle — you must be able to focus on your duties without being distracted by non-operational matters like engaging in conversation with a passenger
- avoiding distractions
- using vehicle lights to convey location — ensure rotating beacon is on when driving on aprons, taxiways and runways

While driving on an aerodrome

- Use extra caution when directed to enter or cross a runway, especially at night and during reduced visibility conditions.
- Use all resources available to keep your vehicle on its assigned route, including:
– aerodrome charts and diagrams
– aerodrome markings, signs and lights.
- Make sure you comply with hold short or crossing instructions when approaching an intersecting runway.
- Make sure you are familiar with radio fail procedures, including tower light



signals. Carry a mobile phone with the tower contact details as a contingency.
- Use utmost caution when operating on a runway where the exit taxiways intersect another runway, in particular when operating at aerodromes with parallel runway systems.

Communications

Effective driver/controller communications are vital to safe aerodrome operations.

You can help enhance the controller's understanding by responding appropriately and using standard phraseology. Guidelines for clear and accurate communications:

Use standard phraseology when contacting ATC to ensure clear and concise communication. Your initial transmission should contain these elements:

– who you are calling
– your call-sign
– where you are located
– a concise description of what you want to do.

- State your position whenever making initial contact with any tower or ground controller, regardless of whether you have previously stated your position to a different controller.
- Focus on what ATC is instructing you to do. Do not perform any non-essential tasks while communicating with ATC.
- Read back any holding position specified in a clearance or instruction and any clearance or instruction to:

– hold short of a runway
– enter a runway
– cross a runway
– conditionally enter or cross a runway.

- Include the runway designator in all readbacks.
- If unfamiliar with the layout of an airport, ask for detailed instructions.
- Clarify any misunderstanding or confusion concerning ATC instructions or clearances

Examples of ATC/driver communications

Requesting tow

Example

Driver :Sydney Ground, Tug Delta Whiskey, request tow Qantas 747 from Qantas maintenance to International Bay 71.

Controller: Tug Delta Whiskey, Sydney Ground, tow approved via Bravo One, hold short of Runway One Six Right.

Driver: Tow via Bravo One, holding short of Runway One Six Right, Tug Delta Whiskey.

Request to enter runway for runway inspection

Example

Driver:Car 2, on Kilo request enter Runway One Six for inspection.

Controller:Car 2, on Kilo enter Runway One Six, report vacated.

Driver: On Kilo, entering Runway One Six, Car 2.

Chapter 3. Role of information technologies on providing safety

The most important function of any safety data reporting system is to validate, collate, analyze, and utilize data to guide directional change towards saferand more reliable operations. This effort depends upon the safety systems' ability to fuse different types of data.The FAA is developing an enterprise-level hazard tracking system that provides tiered access levels to give stakeholders appropriately scaled visibility into the SMS and status of current ongoing safety investigations and reports.

The Safety Management Tracking System supports several agency efforts that involve the collection of runway safety data sets. A critical target for the FAA is the fusion of data that will provide access and clearer unerstanding of runway safety issues. New tools are increasing access and awareness of specific runway safety risks. Data sharing supports the safety community as the transitions to a riskbased aviation system. The move to address performance metrics and develop closer collaboration with airline safety organizations will provide global understanding of where risk exists in the system.

3.1. Runway Incursion Database

The Runway Incursion Database, created and maintained since the 1990's, provides an automated capability to identify, analyze, and monitor trends affecting runway safety. With 77 individual data attributes, the database provides the FAA with a status of specific runway safety issues. At an internal level, the data is used by the RSG for the following tasks:

- Statistical forecasting
- Hazard identification
- Planning of work programs
- Scheduling of personnel resources
- Tracking effectiveness of program activities/ interventions/ strategic initiatives
- Providing the FAA a stable platform to understand the intended and unintended consequences associated with testing new technologies

The Runway Incursion Database fuses data and combines data elements from different sources, within the FAA in order to reveal and highlight unseen latent hazards. The volume of data allows analysts and modelers an opportunity to ask critical safety questions to help the FAA identify precursors to accidents or incidents and provide resolutions and mitigations before accidents or incidents occur.A unique aspect of the database is its transparency. Many of the data attributes maintained in the Runway Incursion Database are available to the general public on the ASIAS web page, allowing students, pilots, airport managers and other aviation professionals access to the data to address their specific requirements. The consistency of data also provides statisticians a valuable source to perform higher level statistic studies.The Runway Incursion Database has provided knowledge and understanding to advance surface safety over the past 16 years and is expected to continue to serve the FAA, industry partners, and other government agencies as a stable data collection and analysis platform well into the future. With further advances in automation, will be continued to evolve the system by incorporating standard safety taxonomy and causal factor identification.

3.2 Evolving Runway Safety Data Collection

According to ICAO, the number of significant runway excursions has not decreased in over 20 years. With the addition of runway excursions to the scope of runway safety, the FAA is establishing the methodology to collect, categorize, and assess relevant data. The FAA participates with multiple regulatory agencies and industry groups to develop actionable plans around the prevention of runway excursions including the ability to merge appropriate data within various FAA organizations. The RSG is the focal point for these efforts.

The RSG is reviewing existing sources of data and data collection methods to begin populating the Runway Excursion database. The primary tasks for the initial development of the Runway Excursion Database include:

- Defining the severity classification and hazard identification processes.
- Providing capability to support communication and outreach activities.

Future versions of the CEDAR system will support the collection of relevant runway and pavement excursion diagnostic attributes as the RSG migrates towards S-RAP for analysis of excursion events.Success metrics modeled after runway incursion metrics will be displayed on the ATO safety dashboard as a means to identify the number of safety improvements identified compared to the safety improvements implemented. A local facility's Partnership for Safety represents a collaborative approach to engaging the workforce in the search for developing mitigations to leading indicators of hazards. The key enabler of Partnership for

Safety is access to objective safety data at the facility level. Quantitative and objective safety metrics are computed regularly and delivered to the local safety council through a secure data portal.

The Safety Data Portal enables the integration, collaboration, and dissemination of relevant data for key safety risks. Additionally, the Safety Data Portal provides facility-level benchmarks to support local operational safety assessments. Development of metrics applied to aggregated national data sets can be used to create a point of reference for individual facilities and provide a basis to perform operational safety assessments of their own operations. To facilitate the development of facility-level benchmarks, facility cohorts were developed. These cohorts provide an objective way of comparing results across like facilities yielding a better comparison of rates and trends.

An important feature of Safety Data portal is a set of safety metrics developed utilizing radar track data fused with other aviation and weather data to allow for causal and classification analysis of leading indicators of risk. These metrics provide the local safety council with the ability to track and trend safety risks that were previously undetectable. Additionally, the surveillance-based metrics provide the local safety council the ability to track the efficacy of their local mitigations while providing a quantitative input to the safety risk management process.

Local Runway Safety Action Plans generate action items and measures that provide the basis for the development of local metrics. Currently tracked in the Runway Safety Tracking System, access by the Local Safety Council of local action items through the Safety Data Portal will create visibility into the assigned status of risk mitigation efforts at the local level.Integration of Airport Construction Advisory Council and Local Runway Safety Action Plan information to the facility Safety Data Portal will be a force multiplier for the RSG efforts and enable the frontline employees to participate daily in runway safety enhancements at the local facility level.

Conclusion

Information provided through analysis of runway incursions is useful in many ways. Analysis of the errors made by pilots, controllers, and vehicle drivers is the first step toward developing error mitigation strategies. Furthermore, successful design of future systems requires knowledge of characteristics of the incursions experienced today as well as the successes and limitations of previously implemented strategies This paper explores what is known about the human errors and other factors that have been identified as contributing to runway incursions, and offers some error mitigation strategies. The data presented will be useful in helping to design the most effective tools for safety, increasing capacity, and for estimating the safety benefits of proposed system enhancements.

Analysis of runway incursions has pointed to specific errors made by pilots, controllers, and airport vehicle drivers that can be mitigated through education, changes in behaviors, and advances in technology (such as the implementation of surface moving maps). However, there is significant room for improvement in the information that is collected and reported. The more detailed the causal factor information in future reports, the more useful this analysis will be. In general, better baseline measures are also needed. Specifically, if the numbers of operations per runway were readily available, the level of risk associated with closely spaced parallel runways could be assessed. Continuous analysis of the runway safety data, combined with improvement of the information collected, and increased availability of baseline performance measures is, and will continue to be, the foundation for improving runway safety.

List of Acronyms

AAS- ARP Airport Safety and Standards

ADS-B -Automatic Dependent Surveillance – Broadcast

AFS -Flight Standards Service

ANSP Air Navigation Service Providers

ALPA -Airline Pilots Association

ASDE-X- Airport Surface Detection Equipment – Model X

ATC- Air Traffic Control

ATM -Air Traffic Manager

CANSO- Civil Air Navigation Services Organization

CCMIS -Certification and Compliance Management Information System

CEDAR -Comprehensive Electronic Data Analysis and Reporting System

CROP-D -Closed Runway Operation Prevention Device

EASA- European Aviation Safety Agency

FAA- Federal Aviation Administration

GPS -Global Positioning System

ICAO -International Civil Aviation Organization

NAS -National Airspace System

NASA- National Aeronautics and Space Administration

NATCA -National Air Traffic Controllers Association

NAVAID- Navigational Aid

NextGen -Next Generation Air Transportation System

NOTAM- Notice to Airmen

NTSB- National Transportation Safety Board

PD -Pilot Deviation

RAP -Risk Analysis Program

RIAT- Runway Incursion Assessment Team

RSA- Runway Safety Area

RSAT -Runway Safety Action Team

RSG -Runway Safety Group

RSTS -Runway Safety Tracking System

SMS -Safety Management System

S-RAP -Surface Risk Analysis Process

SRER- System Risk Event Rate

SRM- Safety Risk Management

SSR -System Service Review

RCAT- Root Cause Analysis Team

RE- Runway Excursion

RESA- Runway End Safety Area

RI -Runway Incursion

RIAT- Runway Incursion Assessment Tea

RRSPM -Regional Runway Safety Program M

RSPM -Runway Safety Program Manager

RSA Runway Safety Area

RSAT- Runway Safety Action Team

RSC -Runway Safety Council

RSG -Runway Safety Group

RSTS- Runway Safety Tracking System

S-RAP Surface Risk Analysis Process

SRER System Risk Event Rate

TRACON Terminal Radar Approach Control

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