FY2010 Task 1, Report 2:

RUNWAY THREAT AND ERROR MANAGEMENT SYLLABUS FITS TRAINING
Review of Pilot Runway Safety Training

Submitted by:
Michele Summers Halleran, M.S.
Embry-Riddle Aeronautical University

May 31, 2010

This effort is the second deliverable under the FITS Program FY2010 Task 1:
Development of a FITS Threat and Error Management syllabus for Runway Incursions

Review of Pilot Runway Safety Training

Introduction

As part of the National Runway Safety Plan, the Office of Runway Safety presents a single national strategy for reducing runway incursions and surface incidents. The plan is coordinated across Federal Aviation Administration organizations, and involves airport operators and airspace system users. The plan identifies and prioritizes activities and objectives the Federal Aviation Administration (FAA) will undertake to improve runway safety. The purpose of the national plan is to provide an overall strategy and ensure that all organizations are working together in a coordinated fashion towards common goals and objectives.

In 2007, the General Accounting Office (GAO) issued a report entitled Aviation Runway and Ramp Safety: Sustained Efforts to Address Leadership, Technology, and Other Challenges Needed to Reduce Accidents and Incidents. The GAO suggested that the FAA develop a forward-looking plan to inform Congress and other aviation stakeholders of the FAA's plans for runway safety management and achieving its performance targets. In early 2009 the Office of Runway Safety published the National Runway Safety Plan for FY 2009 – FY 2011. The National Runway Safety Plan outlines the FAA's goals to improve runway safety including near- and mid-term actions designed to reduce the severity and occurrence of runway incursions. The plan addresses recommendations from the Department of Transportation (DOT) Inspector General, National Transportation Safety Board (NTSB), and the GAO for:
1) Human factors that lead to runway incursions
2) Improvements to airport layout and movement areas to increase safety
3) Improvements to airport signage, lighting and markings, training, education and awareness programs
4) The need for increased industry participation, international cooperation, and the development of various technologies (FAA, 2009a).

The mission of the FAA Office of Runway Safety is "To improve runway safety in the United States by decreasing the number and severity of surface incidents and runway incursions" (FAA, 2009a, pg. 1). This mission is accomplished through the collaboration of the FAA and its many stakeholders in the aviation community. Given the complexities of the runway environment and the relatively infrequent occurrence of runway incursions, the FAA tracks the frequency and severity of runway incursions on a national level to determine if the system is working in addition to looking for specific cause and effect relationships at individual airports. Given the emergence of increasing runway incursions and armed with the Call to Action for Runway Safety previously initiated by the FAA in August 2007, it was time for the FAA to re-emphasize to all its stakeholders the importance of the checks and balances in the system, such as, heightened awareness, training, procedures, technology, a voluntary reporting system, airport signage and markings, and to work together to identify other places where the system may be vulnerable to human error and therefore create potential for runway incursions to occur (FAA, 2009a).

The objective of this research is to develop an FAA/Industry Training Standards (FITS) Threat and Error Management syllabus for runway incursions and wrong runway incidents. To

accomplish this task, this research is divided into four deliverables with the first being a literature review on Threat and Error Management. The second deliverable is a review of the current pilot runway safety training opportunities offered by the FAA and industry. This report will determine current runway safety training areas and emphasis items.

Runway Incursions

On October 1, 2007, as part of its Flight Plan Goal for international leadership, the FAA adopted the International Civil Aviation Organization's (ICAO) standard definitions for runway incursions and runway incursion severity. Beginning Fiscal Year 2008, the FAA defined a runway incursion as "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" (FAA, 2009a, pg.6).

The FAA previously tracked any incident that did not involve potential aircraft conflicts as a "surface incident." Because the FAA did not consider these incidents to be runway incursions, they were tracked and monitored separately. As a result of the FAA's adoption of the ICAO definition, the FAA has a wider range of incursion data to analyze providing for a greater understanding of contributing factors in the occurrence of runway incursions.

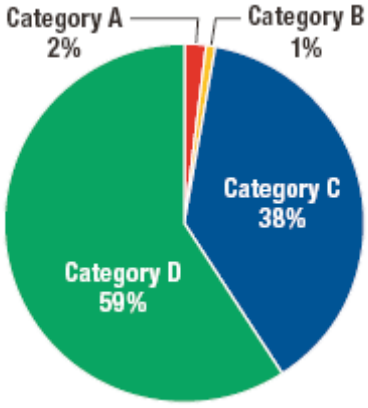
The FAA also adopted the ICAO definitions for runway incursion severity. These definitions categorize those events previously tracked as non-runway incursions in Category D, which are low-risk incidents with either no conflict potential, or ample time or distance to avoid a collision. The majority of runway incursions (See Table 1) in the U.S. were Category C and Category D (see Table 1 and Figure 1) events during the 2005-2008 year period (FAA, 2009a).

Table 1
Runway Incursion Severity Classification

Category	Description
Accident	Refer to ICAO Annex 13 definition of an accident.
A	A serious incident in which a collision was narrowly avoided.
B	An incident in which separation decreases and there is a significant potential for collision, which may result in a time critical corrective/ evasive response to avoid a collision.
C	An incident characterized by ample time and/or distance to avoid a collision.
D	Incident that meets the definition of runway incursion such as incorrect presence of a single vehicle/person/aircraft on the protected area of a surface designated for the landing and take-off of aircraft but with no immediate safety consequences.

Adapted from FAA, 2009a, Annual Runway Safety Report.

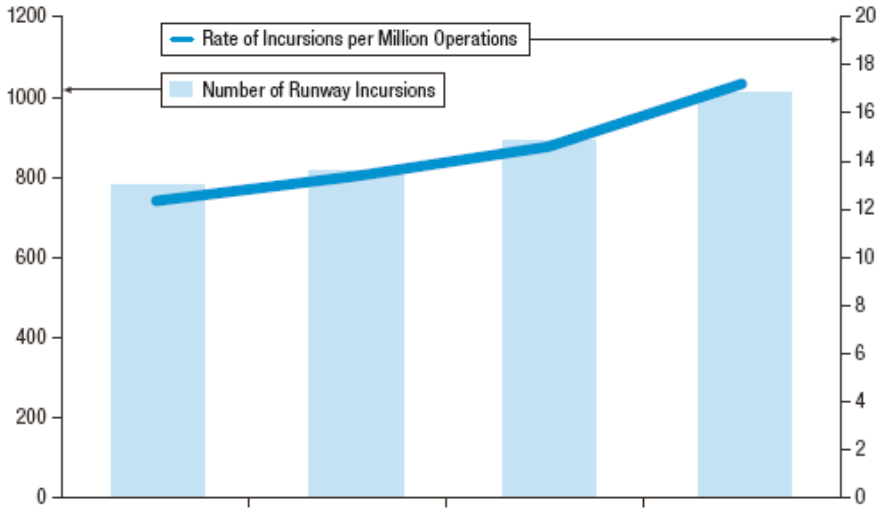
Figure 1
Runway Incursion Severity Distribution Fiscal Year 2005 through Fiscal Year 2008



Adapted from FAA, 2009a, Annual Runway Safety Report.

Based on the new ICAO definitions (See Figure 2), in 2008 there were 1,009 total runway incursions compared to 892 runway incursions in 2007, a 13 percent increase (FAA, 2009a).

Figure 2
Number and Rate of Runway Incursions (Fiscal Year 2005 through Fiscal Year 2008)



	FY 2005 est.	FY 2006 est.	FY 2007 est.	FY 2008	Total
Number of Runway Incursions	779	816	892	1009	3,496
Rate of Runway Incursions per Million Operations	12.3	13.4	14.6	17.2	14.3
Total Number of Operations	63,104,415	61,076,341	61,133,748	58,562,343	243,876,847

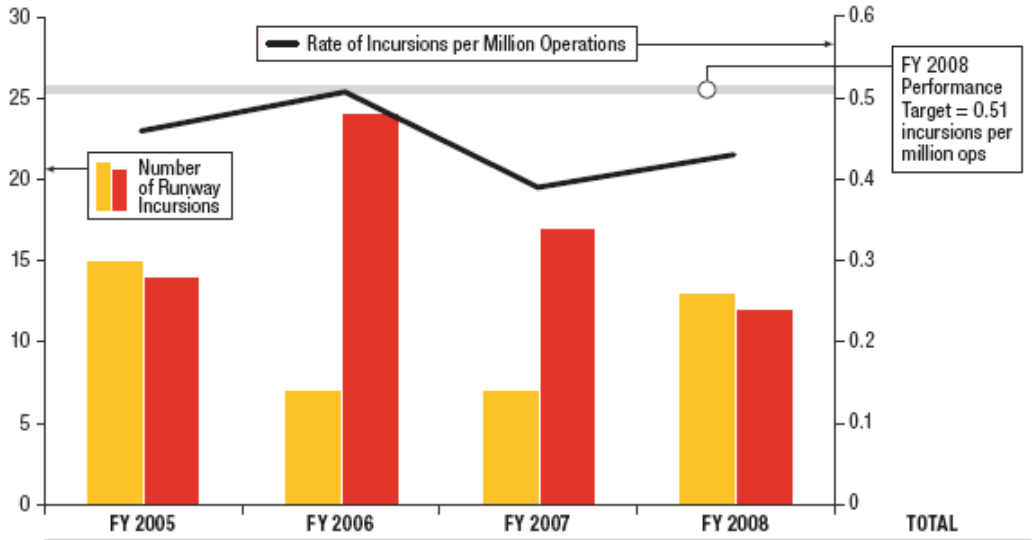
Adapted from FAA, 2009a, Annual Runway Safety Report.
1 FY 2005 through FY 2007 data has been interpolated using the new definition of severity and as such are only estimates. FY 2008 data was collected using the new definition of severity and as such are actual. Reference Data IV

lists the number and rate of runway incursions for all U.S. towered airports that reported at least one runway incursion or surface incident over the four year period.
2 For the purposes of this report, runway incursion data prior to FY 2008 was re-categorized to reflect the ICAO definition, FY 2005 through FY 2007 data shown in the chart above are estimates to reflect the re-categorization.

Of the 25 serious runway incursions (Category A and B) in 2008, nine involved commercial flights. At this rate (nine in over 24 million operations) a person could fly on one commercial flight every day for as many as 3,768 years without encountering a serious runway incursion (FAA, 2009a).

The FAA Flight Plan for 2008 – 2012 performance target is to limit the most serious runway incursions (Category A and Category B) to a rate of no more than 0.45 runway incursions per million operations by 2010 and maintain or improve that rate through FY 2013. The data from 2010 has not been calculated. The FAA Fiscal Year 2008 Portfolio of Goals set forth a performance target of 0.51 runway incursions per million operations specifically for Fiscal Year 2008. The FAA met both of these goals by holding runway incursions to a rate of 0.43 runway incursions per million operations in 2008 (See Figure 3) (FAA, 2009a).

Figure3
Total Number and Rate of Category A and Category B Runway Incursions
(Fiscal Year 2005 through Fiscal Year 2008)



	FY 2005		FY 2006		FY 2007		FY 2008		TOTAL	
	Number	Rate per Million Ops	Number	Rate per Million Ops	Number	Rate per Million Ops	Number	Rate per Million Ops	Number	Rate per Million Ops
Category B	15	0.24	7	0.11	7	0.11	13	0.22	42	0.17
Category A	14	0.22	24	0.39	17	0.28	12	0.20	67	0.27
Total	**29**	**0.46**	**31**	**0.51**	**24**	**0.39**	**25**	**0.43**	**109**	**0.45**

Adapted from FAA, 2009a, Annual Runway Safety Report.

Classification of Runway Incursions

Runway incursions are divided into three classification types. These types include pilot deviations, operational/error deviations, and vehicle/pedestrian deviations (See Table 2) (FAA, 2009a). By definition, a pilot deviation is an action taken by a pilot that results in a failure to comply with an air traffic control clearance and/or instruction (Jenkins, 2008). Operational Error/Deviation is defined as an occurrence, attributable to an element of the air traffic control system, that results in less than the applicable separation minimum between two or more aircraft and obstacles (obstacles include vehicles, equipment, and personnel on runways), or an aircraft landing or departing on a runway closed to aircraft after receiving authorization from air traffic control (ALPA, 2007). Vehicle/Pedestrian Deviations is any unauthorized entry to an airport movement area by a vehicle or pedestrian or failure to follow procedures and/or air traffic instruction (Jenkins, 2008).

Table 2
Classifications of Runway Incursions

Pilot Deviations	Operational Errors/Deviations	Vehicle/Pedestrian Deviations
A pilot deviation (PD) is an action of a pilot that violates any Federal Aviation Regulation. For example, a pilot fails to obey air traffic control instructions to not cross an active runway when following the authorized route to an airport gate.	An operational error (OE) is an action of an air traffic controller (ATC) that results in: 1. Less than the required minimum separation between two or more aircraft, or between an aircraft and obstacles (e.g., vehicles, equipment, personnel on runways). 2. An aircraft landing or departing on a runway closed to aircraft. An operational deviation (OD) is an occurrence attributable to an element of the air traffic system in which applicable separation minima were maintained, but an aircraft, vehicle, equipment, or personnel encroached upon a landing area that was delegated to another position of operation without prior coordination and approval.	A vehicle or pedestrian deviation (V/PD) includes pedestrians, vehicles, or other objects interfering with aircraft operations by entering or moving on the movement area without authorization from air traffic control. NOTE: This runway incursion type includes mechanics taxiing aircraft for maintenance or gate re-positioning.

Adapted from FAA, 2009a, Annual Runway Safety Report.

Table 3
Number of Incursions for Each Runway Incursion Type

	FY 2005	FY 2006	FY 2007	FY 2008	Total
Pilot Deviations	447	507	575	637	2,166
Operational Errors/Deviations	126	111	124	164	525
Vehicle/Pedestrian Deviations	206	198	193	208	805
Total	**779**	**816**	**892**	**1,009**	**3,496**

Adapted from FAA, 2009a, Annual Runway Safety Report.

Pilot deviations are the leading classification of runway incursions (See Table 3). The majority of runway incursions caused by pilot deviations occur during the taxiing out for aircraft departure phase (Jenkins, 2008). An analysis of runway incursion data indicates runway

incursions that cause accidents generally occur at complex, high volume/density airports. The data also show there is a high incidence of runway incursions involving general aviation pilots that often result from misunderstood controller instructions, confusion, disorientation, and/or inattention (Rankin and Cokley, 2007). Because runway incursions can involve and affect such a wide cross section of pilot skill levels and airport operations, runway incursion prevention measures must be as broad in scope as possible.

Runway Safety Strategy

As part of the Runway Safety Strategy on August 15, 2007 the FAA announced the "Call to Action for Runway Safety". The FAA's Call to Action focused on cockpit procedures, air traffic procedures, airport signage and safety markings, technology, and training. Led by the FAA, more than 40 aviation leaders from airlines, airports, air traffic control, pilot unions, and aerospace manufacturers worked together to identify other places where the National Airspace System may be vulnerable to human error and therefore create potential for runway incursions (FAA, 2009a). Table 4 describes two runway incursions that furthered action towards the FAA's updated runway safety strategy.

Table 4
Runway Incursion Events That Prompted Action

Event Date	Airport Code	Airport	Brief Summary
3/21/2006	ORD	Chicago O'Hare	An Airbus A319 was instructed to hold short of Runway 4L, as an another aircraft was exiting the same runway. Simultaneously, an Embraer E145, was instructed to hold short of an intersecting runway. When the aircraft cleared runway 4L, the A319 was cleared for takeoff from Runway 4L. After approximately half-a-minute the Embraer was also cleared for take-off on the intersecting runway. Shortly thereafter the Local Monitor noticed both aircraft were rolling at the same time and told the Local Control, who canceled takeoff instructions to both aircraft. Closest proximity reported was 100 feet horizontal when the Embraer aborted its take-off after having applied maximum breaking. The Embraer had entered the intersection and the A319 had stopped just prior to edge of the intersection.
07/11/2007	FLL	Fort Lauderdale/ Hollywood	An Airbus A320 was instructed to taxi to Runway 9L. The A320 missed a left turn and ended up Runway 9L without a clearance. A go around was issued to a Boeing B757 who was about to touch down on Runway 9L. The B757 executed a go around immediately and over flew the A320 by approximately 50 feet.

Adapted from FAA, 2009a, Annual Runway Safety Report.

Cockpit procedures address the vital communications, such as the completion of safety checklists, which occur between members of a flight crew during all phases of flight, from pushback to arrival. Flight communications must be crisp and precise to ensure that the crew works as an effective team and that a sterile cockpit operating environment is maintained. It is also critical for a flight crew to seamlessly communicate with air traffic control. The FAA asked air carriers to review cockpit procedures to identify and develop a plan to address elements that contribute to pilot distraction during taxi. Of the 112 active air carriers, all have reported that they are in compliance (FAA, 2009a).

Air traffic procedures address the coordination between the flight crew and air traffic controllers. Pilots must effectively coordinate with controllers, and controllers must coordinate with other controllers to maintain constant situational awareness and positive control of movements on the airport surface. The FAA has developed a variety of initiatives designed to improve communication and address explicit taxi instructions between flight crews and controllers, such as Hearback/Readback Awareness Month (FAA, 2009a).

Airport signage and safety markings increase situational awareness for pilots and airport service vehicle operators. These signs and markings are key to helping pilots decide how to proceed safely with routine movements around an airport. Signage and safety markings can be compared with the road signs and painted lane stripes that guide everyday automobile traffic. The FAA regularly updates standards for runway marking and signs, eliminating confusion on airfields. The 75 largest (based on traffic volume) U.S. airports completed enhancements to their surface markings in 2008; the majority of medium- and small-sized airports are on track to meet their future deadlines for enhancing surface markings. A safety review performed by the FAA at 20 airports resulted in more than 100 short-term initiatives, of which all have been completed. Implementation of these initiatives resulted in reducing serious runway incursions (Category A and Category B) by 50 percent (FAA, 2009a).

Technology implementation in the airport environment, control tower and cockpit are designed to support operators in their compliance to procedures and recognition of potential hazards in the runway environment. The FAA is in the process of helping airports across the country install runway safety-enhancing technologies such as Airport Surface Detection Equipment, Model X (ASDE-X), Runway Status Lights (RWSL), and Final Approach Runway Occupancy Signal (FAROS). Low-cost ground surveillance systems are currently being tested at small and medium sized airports, providing scalable and adaptable coverage to the entire airport movement area, addressing poor visibility conditions. This technology provides near-term safety improvements for these airports, providing the future option of layering additional runway safety technologies as needed (FAA, 2009a).

Training provides pilots, air traffic controllers, and ground crews with the skills they need to perform their jobs safely. The FAA issued an advisory recommending initial and regular recurrent ground movement training for all individuals with access to airport movement areas, including non-airport employees. Updated guidance was specifically designed for tug and tow operators to complement existing air carrier tug and tow training programs (FAA, 2009a).

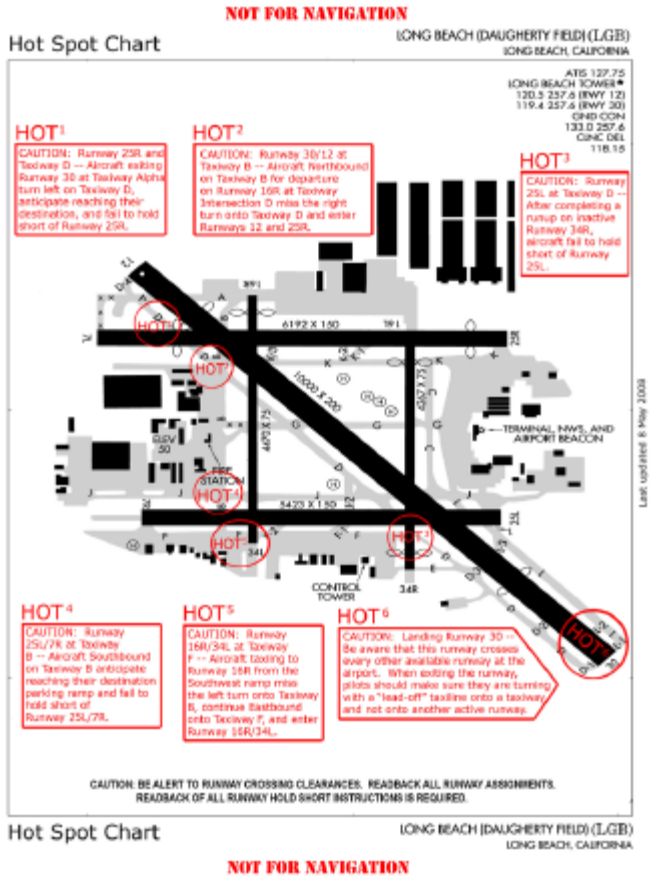
FAA Runway Safety Training Initiatives

Hot Spots

The FAA is in the process of adding “Hot Spots” to National Aeronautical Charting Office (NACO) diagrams to bring attention to movement areas that have previously contributed to the occurrence of runway incursions (See Figure 4). ICAO defines a hot spot as “a location on an aerodrome movement area with a history or potential risk of collision or runway incursion, and where heightened attention by pilots and drivers is necessary” (FAA, 2009a, pg. 13). The use of labels for hot spots on all NACO diagrams will make it easier for users of an airport to plan the

safest possible path of movement in and around that airport. Planning is a crucial safety activity for airport users, both the pilots and the air traffic controllers. By making sure that aircraft surface movements are planned and properly coordinated with air traffic control, pilots add another layer of safety to their flight preparations. Proper planning helps avoid confusion by eliminating last-minute questions and building familiarity with known problem areas (FAA, 2009a).

Figure 4
Hot Spot Chart



Adapted from FAA, 2009a, Annual Runway Safety Report.

While some airports voluntarily labeled hot spots on proprietary versions of their airport diagrams in the past, officially accepted standards for such labeling did not exist. Airports Diagram Order JO 7910.4D, made identification of hot spots standard and mandatory. The FAA recently identified 23 airports as potential candidates to receive official hot spot markings on their respective NACO diagrams (FAA, 2009a).

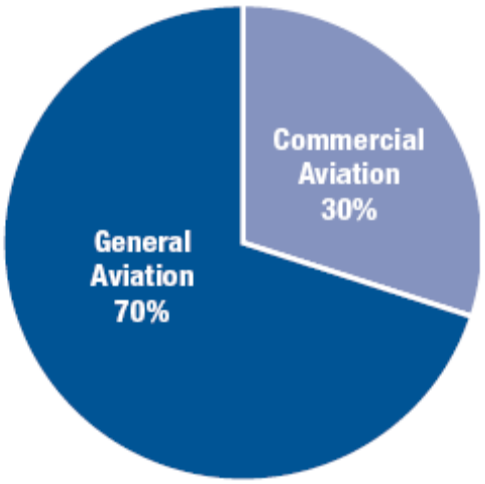
DVD Runway Safety Series for Pilots

The FAA Office of Runway Safety included a four-part runway safety DVD series and brochure in the April 2009 issues of Aircraft Owners and Pilots Association (AOPA) Pilot and Flight Training magazines. The DVD collection includes four videos presenting different aspects of runway safety. The first DVD is titled "Heads Up, Hold Short, Fly Right" and it focuses on maintaining situational awareness by advocating recall of basic principles such as reviewing diagrams of departure and arrival airports, knowing the meaning of industry-standard color-coded runway signage, and asking for help from air traffic control if you are lost.

The second DVD is titled "Was That For Us?" This DVD examines safe taxi operations. The third DVD is titled "Listen Up, Read Back, Fly Right" and it focuses on mission planning, preparation, and pre-flight communication. The final and fourth DVD is titled "Face to Face, Eye to Eye" and it talks about how pilots and air traffic control can work together more efficiently as well as examining the real-world consequences of breakdowns and lapses in communication (FAA, 2009a).

A comprehensive runway safety brochure, *A Pilot's Guide to Safe Surface Operations*, was also included in the distribution. This brochure speaks to safe surface operations and recommends the steps that pilots need to follow in order to ensure surface safety. The brochures and DVDs reached 485,000 pilots and flight instructors, or approximately two-thirds of the U.S. pilot population and a significant number of flight instructors (FAA, 2009a). By making the information in this DVD series and brochure accessible to a wide range of pilot groups, the FAA in turn reached more general aviation (GA) pilots with its safety messages. It is particularly beneficial to reach GA pilots as 70 percent of pilot deviations in 2008 involved general aviation pilots (See Figure 5) (FAA, 2009a).

Figure 5
FY 2008 Runway Incursions categorized as pilot deviations by Operating Type

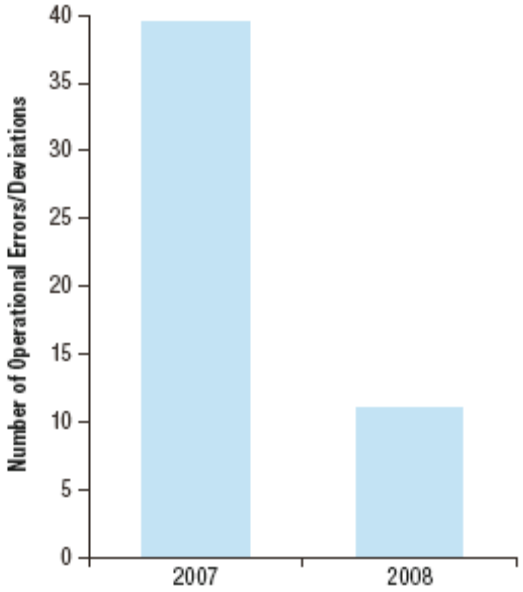


Adapted from FAA, 2009a, Annual Runway Safety Report.

DVD Runway Safety BASICS for Controllers

In 2006 and 2007 the FAA Air Traffic Organization (ATO) Terminal Services and ATO Office of Safety joined together to produce a DVD training series called BASICs. The four DVDs focus on different aspects of the BASIC acronym; the first DVD covers "Be sure the runway is open," the second DVD focuses on "Aircraft position verified," the third on "Scan the runway," and the fourth on "Issue clearances using correct phraseology," and "Close the loop by getting an accurate readback" (FAA, 2009a). The BASICs Series aims to reduce the number of operational errors one of the types of runway incursions, in the Terminal environment (See Figure 6) (FAA, 2009a).

Figure 6
Number of Runway Incursions That Are Operational Errors/Deviations (Fiscal Year 2007 through Fiscal Year 2008)



Adapted from FAA, 2009a, Annual Runway Safety Report.

BASICs DVDs have been distributed to controllers at towered airports throughout the United States; a sample of 20 small, medium, and large airports show a 68 (38 operational errors/deviations in 2007 compared to 12 operational errors/deviations in 2008) percent decrease in operational errors since the DVDs were distributed (FAA, 2009a).

Because the BASICs Series was recognized as valuable, the FAA decided to produce an additional training DVD series for En Route Centers and TRACONs. This new series included a total of five DVDs, which were distributed from Fiscal Year 2008 to Fiscal Year 2010. In August 2008, the FAA sent the first of the additional five DVDs to the field, "Don't Keep Secrets: Airborne Icing and ATC". The goal was to provide Air Traffic Controllers with information on how to recognize meteorological conditions that may cause icing, how encountering icing conditions may affect flight, and how ATC can assist pilots in getting out of icing conditions when encountered (FAA, 2009a).

The second DVD, “Don’t Keep Secrets: Thunderstorms and ATC” was distributed in February 2009 and helps air traffic controllers recognize weather that presents potential hazards to aviation and may be present during thunderstorm conditions, including microbursts and windshear. The DVD also provided information on air traffic controllers’ responsibilities for keeping pilots informed of current weather conditions and assisting in avoiding these conditions. “Positive Separation”, the third DVD, was distributed in August 2009. The remaining two DVDs, “Clear Communications” and “Situational Awareness”, will be released in 2010 (FAA, 2009a).

Hearback/Readback Awareness

ATO Terminal Services actively promoted a “hearback/readback” initiative to enhance active communication between pilots and air traffic controllers. Hearback/readback is a common way of referring to the communication pattern generally accepted as a best practice for pilots and air traffic controllers. Errors in hearback/readback occur when pilots incorrectly repeat instructions to an air traffic controller and the air traffic controller fails to catch the error. Hearback/readback errors are a common aviation communication problem and are a contributing factor in numerous runway safety incidents every year. Hearback/readback errors have the potential to lead to more serious runway incursions. Pilot-controller miscommunications can result in serious breaches in runway safety (FAA, 2009a).

“Hearback/Readback Awareness Month” was held in January 2009 to focus pilot and controller attention on improving communications. A variety of mediums were used to build awareness and focus attention on Hearback/Readback Awareness Month. One of the mediums was posters on situational awareness that were strategically placed in terminal facilities to attract the attention of air traffic controllers. Another medium used was an Adobe Flash Player presentation containing information regarding “Pilot/Controller Loop” and hearback/readback errors, suggestions on how to prevent such communication errors, and an automated auditory replay of a series of hearback/readback situations. A third medium used was future directives for air traffic mangers to coordinate with their local users and develop procedures for sharing hearback/readback events between air traffic controllers and aviation users so errors may be brought to light and addressed on “both sides of the mic” (controllers and pilots) (FAA, 2009a).

Multi-faceted messaging is expected to help reduce the types of surface events that are attributable to hearback/readback errors. By creating the Hearback/Readback Awareness Month campaign, the Air Traffic Organization strengthened its commitment to safety for its users (including military, airlines, general aviation, air taxi and corporate aviation groups).

Constant safety awareness is the key to supporting safe runway operations and preventing errors from cascading into a serious incident. The FAA is using the Runway Safety Management Strategy to encourage aviation professionals to stay focused and constantly keep runway safety in mind while operating in the airport environment. The FAA has built an awareness program using safety analyses and comprehensive training programs, such as National Air Traffic Professionalism (NATPRO) and Crew Resource Management (CRM) training. The programs educate aviation professionals about the dangers inherent to their jobs and keep their minds

focused on mitigating those dangers while operating in the runway environment. The FAA's awareness program's various initiatives are directed toward a range of aviation community members from airport operators to air traffic controllers and pilots (FAA, 2009a).

Airport Surface Analysis

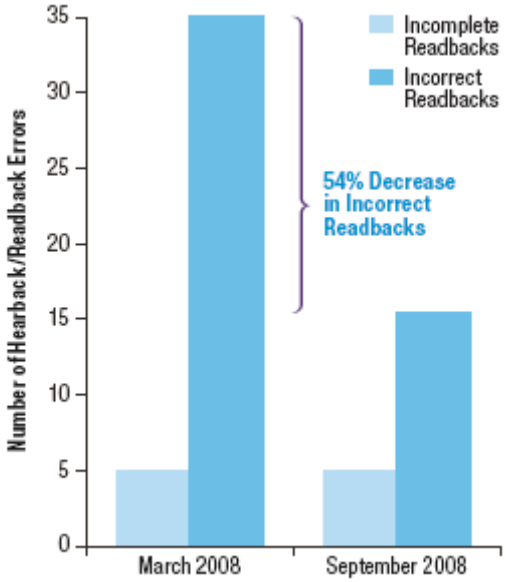
The FAA Office of Runway Safety completed runway safety reviews of 42 (20 in a first tier, 22 in a second tier) airports selected based on runway incursion data and wrong runway departure data. The reviews focused on an analysis of the safety of airport surfaces such as runways (FAA, 2009a). Reviews of the airports have resulted in more than 200 short, mid, and long-term initiatives. There were 5 serious runway incursions at the 20 first tier airports in the 17 months after the reviews, down from 13 serious runway incursions at those airports in the 17 months prior to the reviews. Reviews of the initial surface analysis airports provided a valuable amount of data which has led to many new improvements (FAA, 2009a).

Surface Incident Awareness Month

To raise awareness about runway incursions and promote runway safety, Air Traffic Managers at nine air traffic control facilities declared March and September 2008 as "Surface Incident Awareness Months." The nine airports included:
1) General Edward Lawrence Logan International Airport
2) Newark Liberty International Airport
3) Philadelphia International Airport
4) Detroit Metropolitan Wayne County Airport
5) Hartsfield-Jackson Atlanta International Airport
6) Chicago O'Hare International Airport
7) Dallas/Fort-Worth International Airport
8) McCarran International Airport
9) Los Angeles International Airport

The Surface Incident Awareness Month program placed an emphasis on clear, concise pilot-controller communications and readbacks in order to reduce operational errors that contribute to the occurrence of runway incursions. There was a noticeable reduction in surface incidents at one of the "surface nine" airports during March 2008 and September 2008 (See Figure 7) (FAA, 2009a). Detroit Metro Wayne County Airport (DTW) indicated that in March 2008 it had 40 documented events; five incomplete readbacks and 35 incorrect readbacks. In September 2008, DTW had 21 documented events; five incomplete readbacks and 16 incorrect readbacks. This represents a 54 percent decrease in hearback/readback errors at DTW over this period. The data was collected by Air Traffic Managers at DTW (See Figure 7) (FAA, 2009a).

Figure 7
Number of Hearback/Readback Errors During and After March 2008 at Detroit Metro Wayne County Airport (DTW)



Adapted from FAA, 2009a, Annual Runway Safety Report.

Recurrent Ground Movement Training

In addition to aircraft, airport surface activities involve airport ground equipment and operators. Dozens of airport employees have direct access to airport surfaces, either as pedestrians or drivers of a variety of service vehicles ranging from baggage trucks to large snow removal equipment. In order to prevent vehicle and pedestrian deviations, the FAA's Office of Airports developed procedures for safe ground movement (FAA, 2009a).

Currently, all of the 561 certificated airports in the U.S. require initial and recurrent ground movement training for airport employees such as airport police and maintenance employees. However, 547 of the certificated airports also require recurrent training for non-airport employees such as Fixed Based Operator (FBO) employees and airline mechanics. The FAA asked certificated airports to voluntarily develop plans that require annual recurrent training for all individuals with access to airport movement areas. Additionally, The FAA Office of Airport Safety and Standards issued Advisory Circular 150/5210-20, effective March 31, 2008, which strongly recommends such regular recurrent training for all persons with access to movement areas. This Advisory Circular also provides recommendations and best practices for airports that do not currently have a ground movement training programs (FAA, 2009a).

Some of the airport employees that have access to movement areas are "tug and tow" operators. Tug and tow operators drive ground service equipment that shuttles airplanes when they aren't operating under their own power. To assist air carriers in their ground movement training efforts, FAA's Flight Standards Services developed a new training DVD that addressed updated tug and tow operational procedures. The new DVD supplemented and enhanced current air carrier training programs with updated information pertaining to tug and tow operations. The new DVD

was released to all Code of Federal Regulation (CFR) Federal Air Regulation (FAR) Part 121 and Part 135 operators in December of 2009. An updated Advisory Circular addressing guidance to air carriers regarding tug and tow operations was also released in summer of 2009 (FAA, 2009a).

Industry Training

As mentioned previously in this report, pilot deviations are the leading cause of runway incursions (See Table 3), with the majority of runway incursions caused by pilot deviations occurring during the taxiing out for aircraft departure phase (Jenkins, 2008). Because of this fact, in 2009 the Commercial Aviation Safety Team (CAST) developed runway safety guidelines for all commercial air carrier operators to adapt into their standard operating procedures (SOP). As part the CAST Safety Enhancement 60 Supplemental Implementation Plan, air carrier operators were encouraged to use the *Commonly Used Safe Operating Practices for Taxi Safety* in their training programs and SOP to increase the awareness of threats and error management involved in taxi operations (See Table 5) (CAST, 2009).

Table 5
Air Carrier Threat and Error Management Response Factors

AIR CARRIER THREAT AND ERROR MANAGEMENT RESPONSE FACTORS

Situational Awareness	Properly comprehend taxi clearance and trap inherent errors, and know their position on the airport surface.
See and Be Seen	Adopt techniques to enhance the likelihood of being seen by traffic on final when moving on the airport surface.
Expectation Bias	Resist temptation to expect a certain clearance based on past experience with commonly used movement patterns.
Distraction	Avoid unnecessary distractions that could divert attention from safe taxi.
Haste	Avoid errors and undesired aircraft state resulting from time compression.
Fatigue	Address vulnerability to this ever-present human physiological factor.

Adapted from the Commercial Aviation Safety Team (CAST) Supplemental Implementation Plan (SIP) for CAST Safety Enhancement 60

Since almost two thirds of runway incursions in 2009 resulted from pilot deviations, the FAA required air carriers to retrain their crews (FAA, 2009a). The FAA moved to have the carriers review cockpit procedures to identify and develop plans to minimize pilot distractions during taxi. All 112 carriers have complied with these efforts. Air carriers also are emphasizing their recurrent training programs for non-pilots who operate aircraft or other vehicles on the airfield (FAA, 2009a).

Advisory Circular (AC) 12–74A provides guidelines for the development and implementation of standard operating procedures for conducting safe aircraft operations during taxiing. It is intended for use by persons operating aircraft under parts 121, 125, and 135 (those part 135 flight operations where two or more pilots are in the cockpit) of Title 14 Code of Federal Regulations (FAA, 2003a). However, there are many more effective taxi strategies commonly used by commercial air carriers than are mentioned in the AC 12-74A. Therefore, the CAST developed

the *Commonly Used Safe Operation Practices for Taxi Safety* as exhibited in Table 5 through Table 9.

Table 6
Commonly Used Safe Operating Practices for Taxi Safety (Pre-Taxi)

PRE-TAXI	
Situational Awareness	• All aircraft performance data required for takeoff and departure should be received before commencing taxi. • Flightcrews should— o Verify the correct flight management system (FMS) takeoff runway entries. o Discuss the taxi-out route, including runway incursion hot spots and any crossing runways on the appropriate taxi diagram. • The pilot monitoring (PM) should— o Write down and read back the air traffic control (ATC) clearance before pushback. If the clearance is received as filed, ensure any standard instrument departures (SIDs), transitions, or crossing altitude restrictions are clearly understood. If there is a change in the flight plan, do not accept an abbreviated departure clearance. o Obtain taxi clearance from clearance delivery and ground control. • The pilot flying (PF) should verbalize the taxi clearance back to the PM after receipt. The PM should verify that the PF comprehends the route and clearance limit.
Expectation Bias	• Flightcrews must agree on the runway assigned, the taxi route, and any restrictions. • As part of the taxi brief, the flightcrew should include a plan for handling changes to the briefed departure runway and taxi route, including performance data.
Distraction	The taxi checklist should be eliminated, or vastly reduced through incorporating required actions into the after start checklist performed at the gate.
Fatigue	Flightcrews should recognize that a lack of alertness on a multiple leg domestic schedule can easily lead to a breakdown in prioritization, and errors during task saturation.

Adapted from the Commercial Aviation Safety Team (CAST) Supplemental Implementation Plan (SIP) for CAST Safety Enhancement 60

Table 7
Commonly Used Safe Operating Practices for Taxi Safety (Taxi Out)

TAXI OUT	
Situational Awareness	• The PM should monitor the progress of the taxi. • Flightcrews should be heads up and confirm all clearances to cross or hold short of any runway. • Flightcrews should be aware hold-short lines can be as far as 260 feet laterally from a runway. Because of Precision Obstacle Free Zones (POFZs) or when a taxiway is not perpendicular to the runway, the hold-short line may be reached sooner than expected. • Flightcrews should not accept position-and-hold clearances until the aircraft is ready for departure. • Upon taking the runway, the PF should call out "cleared on runway XX, heading XXX checked."
See and Be Seen	• Before crossing any runway while taxiing to the assigned runway— o Both pilots should scan the full length of the crossing runway for potential conflicts and report "clear left" or "clear right," as appropriate. The PM verifies the clearance and states "clear to cross." The PF acknowledges "clear to cross." o Turn all exterior lights on (leave the landing lights off if they will adversely affect other pilots' vision). ▪ Upon clearing the runway, return to the previous exterior light configuration. • During position-and-hold— o Align the aircraft off centerline during low visibility and night operations to contrast with runway lighting and markings. o Monitor traffic alert and collision avoidance system (TCAS) display (if equipped) for traffic approaching the runway. o Contact ATC if holding in position for more than 90 seconds or upon determination that a potential conflict exists. o Turn on all lights at night (except landing lights) to highlight the aircraft silhouette. • When cleared for takeoff or commencing takeoff roll, turn landing lights and appropriate exterior lights on.
Expectation Bias	• If the departure runway is changed, flightcrews should visually verify the correct FMS takeoff runway entry as part of the taxi and takeoff clearance process. • A clearance to follow another aircraft does not include a clearance to cross any runway.
Distraction	The PF should delay duties that may cause distraction (for example, engine starts, FMS programming, Airborne Communications Addressing and Reporting System (ACARS), and company radio calls) between active runways, crossing active runways, or in runway incursion hot spots.
Haste	The captain should stop the aircraft for the second engine start unless on a long, straightaway taxiway.
Fatigue	Flightcrews should plan ahead in managing cockpit workload levels and prioritizing tasks.

Adapted from the Commercial Aviation Safety Team (CAST) Supplemental Implementation Plan (SIP) for CAST Safety Enhancement 60

Table 8
Commonly Used Safe Operating Practices for Taxi Safety (Taxi In)

TAXI IN	
Situational Awareness	• Flightcrews should brief the taxi plan and/or taxi and runway exit strategy in top of descent brief, emphasizing any runways that the aircraft is expected to cross after clearing the landing runway. • After landing, do not change from tower frequency to ground control until directed to do so.
See and Be Seen	• Before crossing any runways en route to an assigned gate— o Both pilots should scan the full length of the runway for potential conflicts; report "clear left" or "clear right," as appropriate. The PM verifies the clearance and states "clear to cross." The PF acknowledges "clear to cross." o Turn all exterior lights on (leave the landing lights off if they will adversely affect other pilots' vision). ▪ Upon clearing the runway, return to the previous exterior light configuration. • Ensure the aircraft is completely clear of the runway (including the aircraft tail) immediately after landing.
Expectation Bias	• Expect that early automatic terminal information service (ATIS) and arrival/departure information may be updated or changed. o Properly pre-brief well in advance, but… o Expect and be prepared for changes (load alternate arrival procedure, if possible).
Distraction	• When the first officer (FO) makes the landing as the PF (recognize possible threat, which can include role reversal conflicts with normal cockpit duty orientation)— o The flightcrew should adhere to an established formal transfer of control procedure. ▪ Ensure the PF and PM verbalize a positive transfer of control. ▪ The captain announces "I have the aircraft." The FO replies "you have the aircraft." ▪ There is no minimum speed for change of control on the runway. Directional control and braking effectiveness under existing meteorological conditions and aircraft configuration are primary concerns. o The FO should maintain runway centerline. ▪ The FO should not, under normal conditions, attempt to steer the aircraft toward the turnoff taxiway or high speed taxiway unless the captain so directs (based on a perceived need for consistent crosswind control in deceleration, or another significant concern). • The flightcrew should refrain from acknowledging and accepting a clearance during high workload phases of the landing rollout, except for runway exiting instructions. • The PM should not acknowledge ATC radio transmissions until reaching taxi speed and should not contact the company until all runways have been crossed en route to ramp.
Haste	• The captain should delay directing after landing flows and engine shutdowns when between two active runways unless stopped, with the parking brake set. • The PF should not exceed normal braking to comply with an ATC request for an early or expedited turn-off. • Taxi speed should depend on existing conditions, but should be a maximum of 30 knots on straight taxiways.
Fatigue	• Flightcrews should— o Use defensive fatigue management practices whenever circumstances can produce cumulative fatigue. o Assign utmost priority to verifying and adhering to a taxi clearance over nonessential communications and clean-up flows. o Use threat and error management to avoid fatigue-induced haste, which often results in critical omissions or inappropriate decisions.

Adapted from the Commercial Aviation Safety Team (CAST) Supplemental Implementation Plan (SIP) for CAST Safety Enhancement 60

Table 9
Commonly Used Safe Operating Practices for Taxi Safety (Any Time)

ANY TIME	
Situational Awareness	• Flightcrews should ensure the airport diagram, appropriate company guidance material, and hot spot charts are out and available for immediate reference. • Before crossing any runway during taxi, both pilots should make a visual check to ensure there is no conflicting traffic on the crossing runway. Each pilot states "clear left" or "clear right," as appropriate. The PM verifies clearance and states "clear to cross." The PF acknowledges "clear to cross." • Taxi clearances should be reconfirmed with ATC before crossing a runway if any uncertainty exists that the runway is not clear, particularly during low visibility. • If low visibility taxi procedures are in effect, any flight deck-intensive tasks by either pilot should be performed with the aircraft stopped, with the parking brake set. • Flightcrews should be aware of the absence of hold-short stop bars or signage on runways used as taxiways.
See and Be Seen	Illuminate the taxi light during night and low visibility operations. When position uncertainty exists in extremely low visibility, turn on all lights to be seen.
Expectation Bias	• Exercise vigilance for threats inherent in external communications. o Be alert to the threat of similar call signs. Never accept a clearance that has errors (for example, incorrect call sign and wrong runway). o Recognize that monitoring clearances issued to other aircraft, while useful for situation awareness, can lead to an expectation of the identical clearance. o Be wary of ATC phraseology "follow [*a specified aircraft*]," particularly if it involves a runway crossing. Runway crossings are not included in a follow clearance, unless specifically stated. o The PF should stop the aircraft and the PM should request ATC clarification if there is confusion regarding aircraft position or the ATC taxi clearance. • Treat every clearance on its own merits and detail, and do not assume anything that is not specified in the clearance. Always ask for clarification, if necessary.
Distraction	• Flightcrews should— o Remain focused on the primary task: safely taxiing the aircraft. o Insist on and comply with sterile cockpit procedures.
Haste	• The captain should manage the operational tempo and suspend non-monitoring tasks unrelated to the safe operation of the flight when necessary. • Do not accept complex taxi clearances during change of control or during high workload phases of ground operations. • Flightcrews should expect increased risk historically associated with— o High speed taxiways. o Expedite clearances. • The PF should not advance thrust to expedite exiting the runway or the taxiway because of the risk of skidding, tire blowout, runway/taxiway excursion, and brake overheat.
Fatigue	• Recognize that alertness can be enhanced through defensive fatigue management. • Make active listening a priority; communicate freely regarding perceived problems; resolve ambiguities; and trap errors. • Flightcrews should consider approved stimulus (caffeine) intake. • The PF should stop taxiing when either pilot expresses confusion.

CFR Part 91 and 135 Carriers

Advisory Circular 91-73A addresses the single pilot operations and taxi procedures. This Advisory Circular (AC) provides guidelines for the development and implementation of standard operating procedures (SOP) for conducting safe aircraft operations during taxiing. It is intended for use by persons operating aircraft single pilot under parts 91 and 135 of Title 14 of the Code of Federal Regulations (14 CFR). The FAA recommended that these guidelines become an integral part of all SOPs, flight operations manuals, and formal flight training programs (FAA, 2003b).

The potential for runway incidents and accidents can be reduced through adequate planning, coordination, and communication. The following guidelines are intended to help pilots cope more effectively with current airport conditions during taxi operations. These guidelines are separated into two sections. The first section will discuss airport surface operations at a towered airport while the second section will discuss airport surface operations at a non-towered airport and at airports when the tower is closed.

Planning
(Airport Surface Operations at a Towered Airport)

Thorough planning for taxi operations is essential for a safe operation. Pilots should plan for the airport surface movement portion of the flight just as they plan for the other phases of flight. Planning for taxi operations should be an integral part of the pilot's flight planning process and should be completed in two main phases. First, pilots should anticipate airport surface movements by conducting pre-taxi or pre-landing planning based on information on the automatic terminal information service (ATIS), on previous experience at that airport, and review of the airport diagram. Second, once taxi instructions are received, the pre-taxi plans should be reviewed and updated as necessary. CAUTION: A potential pitfall of pre-taxi and pre-landing planning is setting expectations and then receiving different instructions from ATC. Pilots need to follow the clearance or instructions that are actually received, and not the ones they expected to receive (FAA, 2003b).

The following guidance should be used by pilots as a self-check. How familiar are you with the airport? Have you flown out of or into the airport recently? Have there been changes made at the airport recently? Remember to review the latest Notices to Airmen (NOTAM) for both the departure and arrival airports for information concerning construction and/or taxiway/runway closures. Pilots should take some time and study the airport layout. An airport diagram should be readily available for use by the pilot. Pre-taxi plans should focus on the departure airport, and pre-landing plans should focus on the arrival airport. The expected taxi route should be checked against the airport diagram or taxi chart, and special attention paid to any unique or complex intersections along the taxi route. Pilots should identify critical times and locations on the taxi route (e.g., transitioning through complex intersections, crossing intervening runways, entering and lining up on the runway for takeoff, and approaching and lining up on the runway for landing) (FAA, 2003b).

While there may be many views regarding the use of “Airport Diagrams” during taxi operations, the FAA believes that following the aircraft’s progress on the airport diagram to be sure that the instructions received from ATC are being followed is one of the key procedures in reducing runway incursions. This procedure is of particular importance at a time when it is easy to allow oneself to be distracted by outside events. Finally, from a safety argument, the use of “Airport Diagrams” during taxi operations makes perfect sense and should be the SOP for all pilots. Pilots should plan the timing and execution of aircraft checklists and company communications at the appropriate times. When planning these tasks, they should also consider the anticipated duration of the taxi operation, the locations of complex intersections and runway crossings, and the visibility along the taxi route. If possible during low visibility operations, pilots should conduct pre-departure checklists only when the aircraft is stopped or while taxiing straight ahead on a taxiway without complex intersections (FAA, 2003b).

Situational Awareness
(Airport Surface Operations at a Towered Airport)

When conducting taxi operations, pilots need to be aware of their situation as it relates to other aircraft operations going on around them as well as to other vehicles moving on the airport. The pilot should know the aircraft’s precise location on the airport. Sometimes, this is a challenge, especially at an unfamiliar airport, if the airport layout and taxi routes are complex, or the visibility is poor. It is important for the pilot to understand and follow ATC instructions and clearances, have an airport diagram available for use, and know and use all of the visual aids available at the airport, such as the signs, markings, and lighting (FAA, 2003b).

Pilots should use a “continuous loop” process for actively monitoring and updating their progress and location during taxi. This includes knowing the aircraft’s present location and mentally calculating the next location on the route that will require increased attention (e.g., a turn onto another taxiway, an intersecting runway, or any other transition points). All available resources should be used (heading indicators, airport diagrams, airport signs, markings, lighting, and air traffic control – ground and/or tower) to keep the aircraft on its assigned taxi route. Situational awareness is enhanced by monitoring ATC instructions/clearances issued to other aircraft. Pilots should be especially vigilant if another aircraft is on frequency that has a similar call sign. Care should be taken to not inadvertently execute a clearance/ instruction for another aircraft. Prior to entering or crossing any runway, pilots should scan the full length of the runway and scan for aircraft on final approach or landing roll out. If there is any confusion about the scan results, the pilot should stop taxiing the aircraft. CAUTION: Do not stop on a runway. If possible, taxi off the runway and then initiate communications with ATC to regain orientation (FAA, 2003b).

Pilots should be especially vigilant when instructed to taxi into “position and hold,” particularly at night or during periods of reduced visibility. They should scan the full length of the runway and scan for aircraft on final approach or landing roll out when taxiing onto a runway either at the end of the runway or at an intersection. ATC should be contacted anytime there is a concern about a potential conflict. In instances where the pilot has been instructed to taxi into “position and hold” and has been advised of a reason/condition (wake turbulence, traffic on an intersecting runway, etc.) or the reason/condition is clearly visible (another aircraft that has landed on or is

taking off on the same runway), and the reason/condition is satisfied, the pilot should expect an imminent takeoff clearance, unless advised of a delay. If landing traffic is a factor, the tower is required to inform pilots of the closest traffic that is cleared to land, touch-and-go, stop-and-go, or unrestricted low approach on the same runway when clearing them to taxi into "position and hold." Pilots should take care to note the position of that traffic and be especially aware of the elapsed time from the "position and hold" clearance while waiting for the takeoff clearance. ATC should advise pilots of any delay in receiving their takeoff clearance (e.g., "expect delay for wake turbulence") while holding in position. If a takeoff clearance is not received within a reasonable time after clearance to "position and hold," ATC should be contacted. Suggested phraseology: (call sign) holding in position (runway designator or intersection). For example, "American 234 holding in position runway 24L," or "American 234 holding in position runway 24L at Bravo" (FAA, 2003b).

FAA analysis of accidents and incidents involving aircraft holding in position indicate that two minutes or more elapsed between the time the instruction was issued to "position and hold" and the resulting event (e.g., landover or go-around) (FAA, 2003b). Pilots should consider the length of time that they have been holding in position whenever they have not been advised of any expected delay to determine when it is appropriate to query the controller. Pilots should use extra caution when directed to taxi on a runway during reduced visibility conditions. Pilots should use the utmost caution after landing on a runway that intersects another runway or on a runway where the exit taxiway will shortly intersect another runway. Pilots must have a common understanding of ATC's instructions and expectations regarding where the aircraft is to stop and must be able to identify the appropriate hold points. ATC should be advised immediately if there is any uncertainty about the ability to comply with any of their instructions (FAA, 2003b).

After landing, when you are on a taxiway that is between parallel runways, taxi the aircraft clear of the landing runway unless constrained by a hold-short line associated with the adjacent parallel runway. Unless otherwise instructed by ATC, taxi clear of the landing runway even if that requires you to cross or enter a taxiway/ramp area. At an airport with an operating air traffic control tower, never enter a runway without specific authorization. When in doubt, contact ATC. At a non-towered airport or at an airport where the control tower is closed, listen on the appropriate frequency (Common Traffic Advisory Frequency (CTAF)) for inbound aircraft information and scan the full length of the runway, including the final approach and departure paths, before entering or crossing the runway. Remember that not all aircraft are radio-equipped. After landing and exiting the runway, nonessential communications and nonessential pilot actions should not be initiated until clear (on the inbound or terminal side) of all runways (FAA, 2003b).

Use of Written Taxi Instructions
(Airport Surface Operations at a Towered Airport)

At many airports, taxi instructions can be very complex, involving numerous turns and transitions, as well as runway crossing and hold short instructions. During complex airport surface operations, pilots are very busy with a variety of cockpit duties and responsibilities that compete for their attention. Misunderstanding or forgetting any part of the taxi instructions can lead to an embarrassing or unsafe situation. Writing down taxi instructions, especially complex

instructions, can reduce a pilot's vulnerability to forgetting part of a complex instruction and can be used to support airport surface operations. The taxi instructions can also be used as a reference for reading back the instructions to ATC and as a means of reconfirming the taxi route and any restrictions at any time during the airport surface operation (FAA, 2003b).
While written taxi instructions are a good operating technique, common sense and flexibility should be used in determining the need for them at a specific airport. For example, if the departure runway is very near the aircraft parking location, or if the taxi route has been used numerous times in the previous days, it may only be necessary to record the basic elements of the taxi clearance. However, when the taxi instructions are complex or the pilot is unfamiliar with the airport layout, a detailed transcription of all instructions is desirable. Additionally, individual pilots may choose to develop a set of symbols and shorthand notations which allow them to clearly record and later recall key items in the taxi instructions (FAA, 2003b).

ATC/Pilot Communication
(Airport Surface Operations at a Towered Airport)

The primary way the pilot and ATC communicate is by voice. The safety and efficiency of taxi operations at airports with operating control towers depend on this "communication loop." Controllers use standard phraseology and require readbacks and other responses from the pilot in order to verify that clearances and instructions are understood. In order to complete the "communication loop," the controllers must also clearly understand the pilot's readback and other responses. Pilots can help enhance the controller's understanding by responding appropriately and using standard phraseology. Regulatory requirements, the AIM, approved flight training programs, and operational manuals provide information for pilots on standard ATC phraseology and communications requirements (FAA, 2003b).

Some of the most important guidelines that contribute to clear and accurate communications are included in this discussion. Pilots should maintain a "sterile" cockpit. Pilots must be able to focus on their duties without being distracted by non-flight related matters unrelated to the safe and proper operation of the aircraft. When operating an aircraft that does not have a door between the flight deck and the passenger compartment, the pilot may need to ask passengers to refrain from unnecessary conversation from the time the pre-taxi preparations begin until the time the aircraft is clear of the terminal area and at cruising altitude. The same procedure should be followed on arrival, from the time landing preparations begin until the aircraft is safely stopped at the terminal. Pilots should state their position whenever making initial contact with any tower or ground controller, regardless of whether they have previously stated their position to a different controller. Pilots should use standard ATC phraseology at all times in order to facilitate clear and concise ATC/pilot communications. Pilots should focus on what ATC is instructing. Pilots should not perform any non-essential tasks while communicating with ATC. Pilots should read back all clearances/instructions to enter a specific runway, hold short of a runway, and taxi into "position and hold," including the runway designator. Pilots should not merely acknowledge the ATC instructions or clearances to enter a specific runway, hold short of a runway, and taxi into "position and hold" by using their call sign and saying "Roger" or "Wilco." Instead, they should read back the entire instruction or clearance including the runway designator. Air traffic controllers are required to obtain from the pilot a readback of all runway hold short instructions. Pilots should actively monitor the assigned tower frequency or the CTAF

for potential conflicts involving their runway when holding in position for takeoff and when on final approach. Pilots should readback all takeoff and landing clearances, including the runway designator. Pilots should clarify any misunderstanding or confusion concerning ATC instructions or clearances (FAA, 2003b).

Taxiing
(Airport Surface Operations at a Towered Airport)

The following discussion will not include speed management, steering, or maneuvering the aircraft, but will suggest some good practices regarding other cockpit activities during taxi. Prior to taxiing, a copy of the airport diagram should be available for use by the pilot. The aircraft's compass or heading display is an excellent tool, as a supplement to visual orientation, or for confirming correct taxiway or runway alignment. It should be referred to as frequently as necessary, but especially at complex intersections and where the departure ends of two runways are close to one another. When approaching an entrance to an active runway, pilots should verify compliance with hold short or crossing clearance. Low visibility conditions increase the challenge of safely moving the aircraft on the airport surface. Although visibility is technically designated as "low" when the runway visual range falls below 1,200 feet, visibility along the taxi route may be considerably less than the runway visibility. All resources available should be used, including heading indicators, airport signs, markings and lighting, and airport diagrams to the fullest extent possible in order to keep the aircraft on its assigned taxi route. Pilots should perform heads down tasks (e.g., programming the FMS, calculating takeoff data) while the aircraft is stopped. Anytime the pilot becomes uncertain as to the aircraft's location on the airport movement area, stop the aircraft and immediately advise ATC. If necessary, he/she should request progressive taxi instructions. Pilots should give ATC any information available about their position, such as signs, markings, and landmarks (FAA, 2003b).

Do not stop on a runway. If possible, taxi off the runway and then initiate communications with ATC to regain orientation. When cleared to takeoff, or to cross a runway, or when exiting a runway, the pilot should do so in a timely manner. ATC should be informed of any anticipated delay. Some cockpit displays of traffic information (such as some implementations of the Traffic Alert and Collision Avoidance System) have the capability and sufficient resolution to enable the display of traffic behind an aircraft. When pilots are holding in position, they should consider displaying traffic landing behind them to increase their awareness of the traffic situation. When holding in position at night, pilots should consider lining up slightly to the left or right of centerline (approximately 3 feet) to better enable a landing aircraft to visually differentiate the holding aircraft from runway lights. Last-minute turnoff instructions from the tower should not be accepted unless the pilot clearly understands the instructions and is certain that he/she can comply. After landing, pilots should not exit onto another runway without ATC authorization (FAA, 2003b).

Airport Surface Operations At Non-Towered Airports And Airports When The Tower Is Closed

The absence of an operating ATC tower creates a need for increased vigilance on the part of pilots operating at those airports. There are also specific communications procedures that differ from those used at towered airports. As is the case at towered airports, planning, clear communications, and enhanced situational awareness during airport surface operations will reduce the potential for surface incidents at airports without an operating control tower. This section focuses on those aspects of airport surface operations that are unique to airports without an operating control tower and will not be repeated in such detail as the information covered in the Airport Surface Operations At Towered Airports section. The aforementioned should be followed, but when operating at an airport without an operating control tower, there are several items to consider.

Planning (Airport Surface Operations At Non-Towered Airports And Airports When The Tower Is Closed)

The following should be considered when operating at an airport without an operating control tower. Pilots should familiarize themselves with the local traffic pattern. Pilots should remember that not all airports use a standard traffic pattern and that the pattern altitude should be checked. During calm or nearly calm wind conditions, be aware that flight operations may occur at more than one runway at the airport. Also, aircraft may be using an instrument approach procedure to runways other than the runway in use for visual flight rules (VFR) operations. The instrument approach runway may intersect the VFR runway. It is also possible that an instrument arrival may be made to the opposite end of the runway from which a takeoff is being made. Be sure that the taxi plan is understood.

Situational Awareness (Airport Surface Operations At Non-Towered Airports And Airports When The Tower Is Closed)

While maintaining situational awareness is important in all circumstances, it is particularly important when operating at an airport without an operating control tower. To achieve situational awareness, pilots should be fully aware of their intended taxi route and be able to follow the planned route correctly. Without ATC to verbally tell pilots where they should taxi and where and when to stop, they must rely on visual cues to maintain situational awareness and maintain their planned taxi route. These visual cues include airport signs, markings, and lighting, together with the airport diagram. Other things to consider that can help pilots maintain situational awareness while operating at an airport without an operating control tower include the following:

(1) Monitor the appropriate frequency. Pilots should listen to what the pilots of other aircraft on the frequency are saying.
(2) If possible, pilots should monitor the approach control frequency to alert them to instrument flight rules (IFR) traffic inbound to the airport.

(3) Prior to crossing the hold short line or entering or crossing any runway, pilots should scan the full length of the runway, including approach areas. Do not engage in any other flightdeck or cockpit duties while crossing a runway. Full attention must be given to crossing and clearing the runway.
(4) Pilots should use exterior lighting to make their aircraft more conspicuous to other pilots.

Communication and Aeronautical Data (Airport Surface Operations At Non-Towered Airports And Airports When The Tower Is Closed)

Communication rules and guidelines and aeronautical data for operations at airports without an operating control tower differ from those applicable at towered airports. Various regulations, the AIM, approved pilot training programs, and operational procedure manuals provide information to the pilot on standard phraseology, communication, and data requirements (FAA, 2003b).

Taxi (Airport Surface Operations At Non-Towered Airports And Airports When The Tower Is Closed)

Taxi operations require constant vigilance on the part of pilots. Pilots need to be continually aware of the movement and location of other aircraft and ground vehicles. Taxi operations require the same planning, coordination, and proper execution as other phases of flight operations. Sterile cockpit discipline is always appropriate while taxiing, even under normal weather conditions. During low-visibility taxi operations, additional vigilance is absolutely essential. Safe aircraft operations can be accomplished and incidents eliminated if pilots are properly trained and correctly accomplish standard taxi operating procedures and practices (FAA, 2003b).

Before taxiing pilots should verify that current aeronautical data for the airport is obtained, including the operating hours and status of the control tower and airport communication facilities or aids are monitored, i.e., CTAF, flight service station (FSS), or Unicom frequency. When taxing for departure, pilots should monitor the CTAF, FSS, or Unicom frequency. Pilots of departing aircraft should monitor/communicate on the appropriate frequency from engine start, during taxi, and until 10 miles from the airport unless appropriate regulations, local procedures, or operations specifications require otherwise. Pilots should announce all ground movement operations on the CTAF, FSS, or Unicom frequency (FAA, 2003b). When taking the runway pilots should announce their intention to take the runway prior to taking the runway. Pilots should also announce their intention to takeoff on the CTAF, FSS, or Unicom frequency. Pilots should not line up on the departure runway and hold any longer than absolutely necessary. Pilots should always state the name of the airport at the beginning and end of the radio transmission. Some aircraft operating at airports without operating control towers may not be equipped with a radio. Pilots must remain alert for them (FAA, 2003b).

Use of Exterior Aircraft Lights to Make Aircraft More Conspicuous

Exterior aircraft lights may be used to make an aircraft operating on the airport surface more conspicuous. Pilots may use various combinations of exterior lights to convey their location and intent to other pilots. Certain exterior lights may also be used in various combinations to signal whether the aircraft is on a taxiway or on a runway, in position on the runway but holding for takeoff clearance, crossing an active runway, or moving down the runway for takeoff. Because aircraft equipment varies, pilots are cautioned not to rely solely on the status of an aircraft's lights to determine the intentions of the pilot(s) of the other aircraft. Additionally, pilots must remember to comply with operating limitations on the aircraft's lighting systems (FAA, 2003b).

To the extent possible and consistent with aircraft equipage, operating limitations, and pilot procedures, pilots should illuminate exterior lights differently depending on the aircraft configuration. For example, with the engines running, pilots should turn on the rotating beacon whenever an aircraft engine is running. Prior to commencing taxi, pilots should turn on navigation, position, anti-collision, and logo lights, if available. To signal intent to other pilots, consider turning on the taxi light when the aircraft is moving or intending to move on the ground, and turning it off when stopped, yielding, or as a consideration to other pilots or ground personnel. Strobe lights should not be illuminated during taxi if they will adversely affect the vision of other pilots or ground personnel. While crossing a runway, all exterior lights should be illuminated. Pilots should consider any adverse effects to safety that illuminating the forward facing lights will have on the vision of other pilots or ground personnel during runway crossings. When entering a runway after being cleared for takeoff, or when taxiing into position and hold, pilots should make their aircraft more conspicuous to aircraft on final behind them and to ATC by turning on lights (except landing lights) that highlight the aircraft's silhouette. Strobe lights should not be illuminated if they will adversely affect the vision of other pilots. The SOP of turning on landing lights when takeoff clearance is received is a signal to other pilots, ATC, and ground personnel that the aircraft is moving down the runway for takeoff. Landing lights should be turned on when takeoff clearance is received, or when commencing takeoff roll at an airport without an operating control tower (FAA, 2003b).

Emphasis Items for Pilots

The best practices were developed by staff from the FAA to help pilots improve safety by giving guidelines that should be followed to keep skills and focus current and vigilant. More than 80% of pilot caused runway incursions occur during taxi to the departure runway (FAA, 2009b).

Pre-Flight Planning

Best practices for all pilots should include the following:

1. Review and understand airfield signage and markings.
2. Review the appropriate airport diagrams.
3. Review any Hot Spots identified on the diagram.
4. Print a copy of the airport diagram for use in the cockpit.

5. Review airfield NOTAMS and current ATIS for any taxiway closures, runway closures, construction activity, or other airfield specific risks.
6. Brief any passengers on the importance to minimize discussions, questions, and conversation during taxi (maintain a “sterile cockpit”) (FAA, 2009b).

Taxi

Best practices for all pilots should include the following:

1. Have the airport diagram out and available for immediate reference during taxi. Use the FAA runway safety website to find airport diagrams for all airports.
2. Review current ATIS for any taxiway closures, runway closures, construction activity, or other airfield specific risks.
3. During radio transmissions, use correct terminology and proper voice cadence.
4. REMEMBER: WHEN IN DOUBT, ASK! (FAA, 2009b).
5. Eliminate distractions in the operational area.
6. Maintain a sterile cockpit when taxiing.
7. Maintain appropriate taxi speed.
8. Encourage pilots to have their "eyes out" when taxiing.
9. Encourage pilots to have a "heads up" policy when taxiing (FAA, 2010).

Communication

Best practices for all pilots should include the following:

1. Encourage use of correct terminology and proper voice cadence.
2. Readback all runway hold short instructions (FAA, 2010).

Standard Operating Procedures (SOP) Template for Pilot Ground Operations and the Prevention of Runway Incursions

A manual or section of a manual that serves as the pilot’s guide to SOPs may double as a training guide. The contents should be clear and comprehensive. This template includes topics that industry and the Federal Aviation Administration (FAA) have selected as useful for developing effective SOPs for operations on the ground and on approach with an emphasis in the prevention of runway incursions. It does not include every topic that might apply, such as those that apply to special operating authority or new technology (such as Extended Range Operations with Two-Engine Airplanes, Precision Runway Monitor, Surface Movement Guidance System, and required navigation performance) (FAA, 2003b).

- Captain’s authority

- Use of automation
  - The operator’s automation philosophy
  - Specific guidance in selection of appropriate levels of automation
  - Autopilot/flight director mode control inputs
  - Flight Management System (FMS) inputs

- Checklist philosophy
  - o Policies and procedures (who calls for, who reads, who does)
  - o Format and terminology
  - o Type of checklist
    - Challenge-Do-Verify
    - Do-Verify
  - o Walk-around

- Checklists
  - o Safety check – power on
  - o Originating/receiving
  - o Before start
  - o After start
  - o Before takeoff
  - o Preliminary landing
  - o Landing
  - o After landing
  - o Parking and securing
  - o Emergency procedures
  - o Non-normal/abnormal procedures

- Communications
  - o Who handles radios
  - o Primary language used
  - o Air Traffic Control (ATC)
  - o On the flightdeck
  - o Keeping both pilots in the loop
  - o Company radio procedures
  - o Flightdeck to cabin signals
  - o Passenger briefing
  - o Cabin to flightdeck signals
  - o Procedure to review/crosscheck clearances
    - Cross or hold short of a runway
    - Taxi into position and hold
    - Takeoff
    - Land

- Briefings
  - o Controlled Flight Into Terrain (CFIT) risk consideration
  - o Special airport qualifications
  - o Special security considerations
  - o Temperature considerations
  - o Before taxi
  - o Before takeoff
  - o Descent/approach/missed approach

- Flightdeck access
  - o Onground/in-flight
  - o Jumpseat
  - o Access signals, keys

- Flightdeck discipline
  - o Sterile cockpit – in-flight and on the ground
  - o Maintaining outside vigilance
  - o Transfer of control
  - o Additional duties
  - o Flight kits
  - o Special security equipment
  - o Headsets/speakers
  - o Boom mikes/handsets
  - o Maps/approach charts
  - o Meals

- Boarding passengers/cargo
  - o Special security considerations
  - o Carry-on baggage
  - o Exit row seating
  - o Hazardous materials
  - o Prisoners/escorted persons
  - o Guns onboard
  - o Count/load

- Pushback/powerback

- Taxiing
  - o Single engine
  - o All engines
  - o Contaminated Runways
    - Ice
    - Snow
    - Water
    - Slush
  - o Prevention of runway incursions
    - Use of airport diagram
    - Crew confirmation of taxi clearance
    - Visually clear final approach path and the runway before crossing or taking any active runway
    - Complex intersections, airfield construction, and “hot spots”

- Crew Resource Management (CRM)
  - Crew briefings
    - Flight attendants
    - Flightcrew

- Weight and balance/cargo loading
  - Who is responsible for loading cargo, and securing cargo
  - Who prepares the weight and balance data form; who checks it
    - Copy to crew

- Flightdeck/cabin crew coordination
  - Boarding
  - Ready to taxi
  - Cabin emergency
  - Prior to takeoff/landing

- Approach philosophy
  - Precision approaches preferred
  - Stabilized approaches standard
  - Use of navigation aids
  - FMS/autopilot
  - Approach gates
  - Limits for stabilized approaches
  - Use of radio altimeter
  - Briefing for expected runway prior to beginning approach
  - Go-arounds:
    - Plan to go around
    - Change plan to land when visual, if stabilized

- Individual approach type
  - All types, including engine-out

- For each approach
  - Profile
  - Flap/gear extension
  - Callouts
  - Procedures

- Go-around/missed approach
  - When stabilized approach gates are missed
  - Procedure
  - Callouts
  - Clean-up profile

- Landing
  - o Actions and callouts
  - o Configuration for conditions
    - Visual approach
    - Low visibility
    - Contaminated runway
  - o Close-in turns
  - o Crosswind
  - o Rejected
  - o Transfer of control after first officer landing
  - o Anticipated landing runway and taxiway exit designation and direction of turn to the first hold short point (FAA, 2003b).

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