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FAA Report Surveys U.S. Airline Pilots To Discover Factors That Promote Runway Incursions

Pilots cited poorly timed and expressed taxi instructions, inadequate signage, difficult-to-follow charts and radio frequency congestion, among other problems.

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Aviation Writer

After a 15-hour flight from Australia, a tired captain and first officer were executing a landing rollout at 140 knots when a tower controller's voice came over the radio at the busy U.S. West Coast airport.

With the thrust reversers roaring and the cockpit vibrating, the pilots strained to make out the taxiing instructions. This is what they heard, annotated by the pilot's doubts [in brackets]:

"Make the next high-speed turn, hold short of [*or was it cross?*] 25-L, contact ground [*or was it 'stay with me'?*] on 121.65 [*or was it .75?*]."

The pilot later complained: "Gets kind of busy! During this transmission I also have to monitor: engine reversers normal, call out decreasing airspeed every 20 knots, monitor ground speed for turn-off, change radio frequency, reversers stowed, brakes normal."

It is a concern expressed by many pilots: having to monitor air traffic control (ATC) taxiway instructions during landing and rollout. And it is also one of many factors that can make it tougher for pilots to avoid the mistakes that sometimes lead to runway incursions and related airport-surface incidents.

Each year, between 200 and 300 runway incursions are reported at U.S. airports, creating what the U.S. Federal Aviation Administration (FAA) calls collision hazards. And every few years, runway or taxiway collisions occur. In most cases, researchers say, such collisions could have been avoided.

An FAA-sponsored study based on a survey of 1,908 airline pilots, conducted and analyzed by The MITRE Corp. of McLean, Virginia, U.S., found that pilots, airport operators, air traffic controllers and airlines could do far more to lessen the potential for errors that lead to runway incursions and related airport-surface incidents.

The FAA defines a runway incursion as "any occurrence at an airport involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of separation with an aircraft taking off, intending to take off, landing or intending to land." In other words, there is a conflict between an aircraft landing or taking off, and another aircraft or vehicle on or near the runway.

Under the category of "related surface incidents," the FAA includes incidents — such as crossing a runway without authorization from ATC, taking off without clearance or landing on the wrong runway — that would be incursions except that no other vehicles happen to be in conflict at the time, so that there is technically no loss of separation.

"Multiple factors can contribute to or cause pilot error," the report found, "including unfamiliarity with the airport, inadequate surface navigation aids, difficulties with ATC communications, and insufficient cockpit crew procedures and verbal coordination."

The report suggested numerous possible changes to lessen the chances for pilot error and runway incursions. Those changes

included clearer and more standardized painted markings on runways and taxiways; improved airport charts; more reasonable cockpit workloads; and better ATC communications.

"The necessary changes in airport surface operations involve all of the parties to these operations: the airport operators, the airlines, the pilots, the FAA, the air traffic controllers, the airport chart manufacturers and relevant segments of the aviation industry," the report suggested.

MITRE surveyed pilots from two major U.S.-based airlines, which were not named. The survey questionnaire included a mixture of open-ended questions and multiple-choice questions. The pilots were encouraged to add comments to their answers to provide further insights.

Portions of the 200-question survey were sent to 9,497 airline pilots, of whom 1,908 responded. Because they were only asked to respond to specific portions of the survey, the number of pilots answering any given question typically ranged between 45 and 130.

Researchers who conducted the study believed that they contacted a representative sample of pilots, but did not try to structure the questions to be able to collect data suitable for formal statistical analysis. The two large airlines for which the pilots worked "serve most of the domestic airports in the United States, and both have international routes to [non-U.S.] airports," the report said.

The study is the first report based on the pilots' questionnaire responses. This report covered surface navigation aids (published airport charts, as well as airport signs, markings and lighting); cockpit procedures for pilot orientation on airport surfaces; and ATC-pilot and intracockpit communication on the ground.

Later reports to be issued by MITRE will assess the pilots' responses to questions about memory, attention, FAA regulations and compliance with ATC instructions. In general, the survey reports are intended to help those involved in the operations of aircraft at airport runways and taxiways.

In 1986, the U.S. National Transportation Safety Board (NTSB) reported on its investigations of 26 runway incursions (including some accidents) that were caused by pilot or air traffic controller mistakes. In its "most wanted" lists of safety recommendations, the NTSB has called every year for further steps to help prevent runway incursions.[1]

In a March 1993 report, MITRE's Center for Advanced Aviation System Development studied the responses of pilots who had been involved in 75 surface incidents during eight months, in interviews conducted by experts from the National Aeronautics and Space Administration's (NASA's) Aviation Safety Reporting System (ASRS).[2]

Those pilots most often cited deficiencies in their own performances as the cause of their errors on runways or taxiways. But they also cited as factors (in decreasing order): ATC communication problems; memory problems; ATC and airline deficiencies, either operational or procedural; and problems with maintaining proper orientation on the airport's surface.

In another study, published in November 1993, experts from MITRE examined data from the FAA's Office of Accident Investigation on surface incidents reported during one year as potential or actual runway incursions.[3]

The FAA office had classified nearly two-thirds of those airport incidents as possibly resulting from pilot deviations. But the FAA data "did not provide sufficient detail to allow identification of specific factors that would explain why these events occurred or what contributed to the apparent human errors," the report said.

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Collecting sufficient detail was a major purpose of the 65-page questionnaire that MITRE researchers sent to pilots for its latest report. After receiving the completed forms, MITRE experts analyzed and categorized the responses. In general, they found that pilots often must cope with situations on airport surfaces that make them vulnerable to the possibility of making errors. But many pilots are not using all the teamwork that is available to avoid runway incursions and related incidents.

"It is clear that certain situations cannot be changed, such as those involving the loss of some visual cues through either surface contamination or low visibility, the layout of runways and taxiways at established airports and the onset of fatigue during the work period. Ways must be found to help pilots cope successfully with such situations," the report said.

"Other situations can be changed, such as those involving signs and painted markings, airport charts, workloads and ATC communications. It may be difficult to make all the necessary changes, but much can be done."

Also, researchers asserted, "Pilots can cope more effectively with many of the situations they encounter by using cockpit procedures and crew teamwork that help prevent or catch errors."

Noting such procedures now used in other critical flight phases, such as callouts and checklist responses during landing and takeoff, the report said that "this same care and attention to detail are now required on the ground, because the airport

surface has its own hazards — a point that has become obvious with the increased traffic and expanded network of runways and taxiways at complex airports ... ."

The pilots surveyed offered long lists of problems and complaints, along with numerous recommendations about surface operations.

Unfamiliar or confusing airports. "Controllers should be trained that the set of instructions they just 'ripped' off for the 50th time that day and the 5,000th time that year may be the first time the pilot ever hears them," one pilot wrote. That pilot was not alone in expressing irritation at controllers who, according to the pilots, assume that all pilots know all airports. In fact, many pilots are not familiar with all the airports they must fly into, even some of the nation's busiest airports.

More than half of the pilots who responded to the survey said that they had made recent flights into unfamiliar airports, a result that contradicts the general belief that pilots with major airlines are acquainted with most of the domestic airports they fly into.

"Ground control should slow down their delivery and assume that the crew is unfamiliar with the airport," another pilot wrote.

More than half of the pilots who responded to the survey said they had made recent flights into unfamiliar airports.

The report found that familiarity is often related to an airport's complexity. "Pilots can feel unfamiliar with the airport layout or the ATC operations at a busy, complex airport even if they have flown into it several times before," the report said. "Yet they can feel comfortably familiar with another airport after one or two flights made months earlier."

To help pilots cope with unfamiliar airports, the study suggested that "all surface operations at all airports must be designed to work properly with unfamiliar pilots." The report recommended that the FAA, airport operators and airlines keep that suggestion in mind when they redesign surface navigation aids, ATC procedures and communications, cockpit crew procedures and pilot communications on the ground.

Many pilots complained that the charts of airport taxiways and runways are too small and difficult to read.

The report concluded that "the charts are not easy to read in all situations. More work is needed on finding ways to make the charts easier to read and understand at a glance, including increasing their size."

One difficulty of reading the charts is "translating that plan view into the actual path to follow, as seen through the cockpit window," the report said. "It would be preferable to have some way of displaying the immediate segment of the route to the pilot in the pilot's field of view when looking ahead out of the cockpit window."

The report recommended that the chart manufacturers "continue to seek ways of making it easier to read the alphanumeric symbols on complex airport charts at the viewing distances and under the lighting conditions available in the cockpit." The report suggested that the FAA "encourage industry's research and development of automated devices in the cockpit that show the aircraft's position progressively in relation to the airport layout during taxi ... ."

One way to help pilots learn in advance about unfamiliar or complex airports would be to make videotapes that would show what pilots see when taxiing at destination airports, especially those with confusing taxiway layouts, the report said.

"The problem for most pilots is translating the plan-view diagram of an airport layout into the view from the cockpit window," the report said. "A videotape viewed before the flight … could be a guide, especially if it were short and dealt only with one or two of the most confusing intersections ... ."

The report recommended that the FAA work with pilot and airport representatives to consider the best ways of developing visual aids for pilots. It was also suggested that the FAA "produce and disseminate visual aids" to help pilots prepare for operations at unfamiliar or complex airports, beginning with visual aids for a few selected airports.

Problems with airport surface navigation aids. The largest group of written comments in the survey (354 comments, provided by 210 pilots) came from pilots who complained about confusion and complexity of airport taxiways and runways.

"The lack of standardized markings of large size, easily visible, at U.S. airports is appalling," one pilot wrote. A colleague added that the "number one cause of runway incursions is [the] lack of adequate taxiway and runway signs and markings."

Another pilot with 20 years of experience said, "I still make errors" at taxiways and runways "because there seems to be no continuity. Different airports have different types, sizes and shapes of signs — not to mention color. The placement of signs is also confusing — it is very easy to misunderstand what taxiway goes [with] which sign."

U.S. airports have no consistent way of designating taxiways. Some airports identify taxiways by simple letters; some use names (e.g., "Wolf," "Cat" at Detroit); some use letter-number combinations (e.g., "U-45," "K-28" at Los Angeles). Pilots' suggestions included requiring all airports to "have a standard

way to name taxiways — logically, and in sequence." One suggested alphabetical or numbered taxiways; another recommended "a proper letter or number progression (1, 2, 3; A, B, C; A1, A2, A3)." Another advised: "Don't use names, only letters and numbers."

The report concluded that "there is a lack of standardization, as well as maintenance, of both signs and markings." The study suggested that "critical information needs to be conveyed in redundant ways."

In a recent Advisory Circular (AC-150/5340-1G), the FAA listed new standards for surface-painted taxiway direction and location markings. But the AC did not set a compliance date for airports to conform to the AC, which also did not describe or define the kinds of airport intersections that would require the recommended painted markings.

Another FAA AC (120-57) sets standards for developing a Surface Movement Guidance and Control System at U.S. Federal Aviation Regulations (FARs) "Part 139" airports. The AC requires airports to plan for in-pavement lights at the holding positions for conducting operations in visibility of less than 1,200 feet (366 meters) runway visual range (RVR), "stop bars" (a pattern of red lights) for operations in visibility below 600 feet (183 meters) RVR and other locator and status lights.

But the report said that the FAA AC "does not address the need for making the hold lines stand out through such redundant means at airports that will operate only in less severe visibility conditions."

The report suggested that another problem with the current airport markings "is the lack of distinctive surface markings on the runway side of hold lines: there is nothing to differentiate between the yellow centerline of a taxiway before the hold line, and the similar yellow lines used after hold lines that show either the taxi route across the runway or the exit from the runway to the taxiway."

Following on the pilots' critique, the report listed numerous recommendations to improve airport taxiway and runway signs, markings and lighting.

Noting that the FAA AC's new requirements may not "solve all problems at all airports," the study recommended that the FAA "establish points of contact for pilots and controllers to report problems with signs at specific airports." The report also suggested that the FAA assist airports in solving the signage problems that are reported.

"A gallon of paint would do wonders to mark the various taxiways at all airports," one pilot commented. Another said that there is a "desperate need for improved taxiway markings."

And yet another called for hold markings that are "loud, bright, clear and standardized."

The report said that "there is a need for very specific guidance right on the taxiway surface where pilots are looking when taxiing through intersections having the potential for causing confusion and possibly actual disorientation."

Therefore, the report suggested that the FAA revise AC-150/5340-1G to add "specific requirements for the use of the new surface-painted markings showing taxiway direction and location."

The report also suggested that the FAA ask pilot organizations and air traffic controllers to help identify those intersections that need surface-painted markings to show taxiway directions and location. In addition, the FAA should make it easier for pilots and controllers to report problems at specific airport intersections, and to work with airport operators to schedule completing taxiway direction and location markings.

[A pilot] called for hold markings that are "loud, bright, clear and standardized."

In addition to taxiway markings, the report found, pilots sometimes miss airport "hold lines." The report suggested that "redundant surface markings would alert pilots to start looking for [the hold line]. Different markings on the runway side would enable pilots to recognize quickly that they had passed it."

The report suggested that the FAA add such standards to its surface-marking circular, and work with pilot and airport representatives to help devise "a way of adding redundant painted markings on the taxiway surface prior to the hold line to indicate an approach to the hold line."

"We need lighting to warn us of crossing runways," one pilot wrote. Another called for "some sort of stop/go (red/green) lighting system at taxiways used to cross the active runways."

Lighting on taxiways was a common pilot complaint, and the report said that "attention-getting lighting systems should be installed eventually at all taxiway-runway intersections." Such lights "should be planned for the near term at notoriously confusing intersections," the report added.

The report recommended that the FAA develop better lighting systems and work with pilot and controller groups to identify the taxiway-runway intersections that most need such lights.

Enhancing pilot-controller communications. When an airliner is on a taxiway or a runway, the only interface is voice communication between pilots and the control tower. But as airport congestion increases, that communication can become a vulnerable part of the safety system.

"The voice communication that worked effectively with less traffic is now strained to the breaking point during peak traffic periods," the report found. "At these times, controllers cannot communicate with the pilots in the way ATC-pilot communication was designed to work.

"The original design intentionally included safety measures such as proper timing and readbacks, which are now being dropped so that more ATC instructions can be crowded onto the frequencies at busy times. Yet these are the times when the consequences of errors may be more critical, and safety measures are needed the most." The report added that "any breakdown of the ATC-pilot interface can be critical to safety."

The landing and rollout phase is perhaps the busiest and most stressful time in airline cockpits, the report said.

"Giving instructions prior to the aircraft clearing the runway — when pilot workload is high — is asking for trouble," one pilot warned.

"The constant flow of instructions during landing and rollout is most disturbing," wrote another pilot. "This is a high-workload time, especially if the FO [first officer] was flying and control is being transferred to [the] captain."

Another pilot complained: "Wait until we are at taxi speed, or issue instructions on final above about 500 feet [152 meters] (visual conditions only!). I'm tired of getting instructions at 80 knots on rollout."

"Critical instructions … need to be issued well before the pilots begin the landing."

One problem with ATC instructions during landing and rollout can be loud background noise that makes it difficult for the cockpit to hear radio messages.

A pilot wrote, "It's very loud [reversers], vibrating, transferring control from FO to captain. Landing rollout is a poor time for any instructions, much less complicated ones including specific turnoffs, frequencies, instructions etc. I simply ignore them until aircraft is slowed to a safe controllable speed."

Generally agreeing with the pilots' complaints, the MITRE researchers concluded that "critical instructions regarding holding short of an intersecting runway or holding short of a closely spaced parallel runway after exiting the arrival runway need to be issued well before the pilots begin the landing."

The report recommended that the FAA instruct controllers to keep communications to an essential minimum during the landing/rollout phase, and conduct more research into which communications are necessary then.

Frequency congestion. "The frequency congestion at busy airports … is out of control and a great source of irritation," one pilot complained.

Another pilot said, "Too many aircraft are on the same frequency, getting info they don't need. Sometimes controllers will say something like: 'Don't call me, just listen up.' "

During peak traffic periods, controllers are often so busy that they speak too rapidly on congested airport ground-control frequencies — sometimes not providing opportunities for pilots to verify the instructions in a readback, the report said.

"The rapid speech rates and inability to read back increase the likelihood that parts of the instructions will be missed or misunderstood," the report found. "This is a breakdown of safety measures that were built into the ATC-pilot communication interface."

The report concluded that frequency congestion has become "a major communications issue that adversely affects the issuance and readback of ATC instructions." With increasingly congested airports, the problem "has now worsened to the point of compromising the primary interface between pilots and controllers for the movement of aircraft on the airport surface."

The report found "an urgent need to reduce the amount of information exchanged by voice between pilots and ATC on the airport surface." The researchers suggested that the FAA develop and quickly implement "standard taxi routes at all busy airports to replace the issuance of complex taxi instructions by voice."

The report recommended that the FAA provide more support "for developing, evaluating and certifying some form of data link or other nonvoice means of exchanging information between ATC and pilots during surface operations."

Different airports use varying procedures to let pilots know when to switch radio frequencies from ramp control to ATC ground control, and when to switch from ATC ground control to tower control when taxiing for departure.

"There is a need for more consistent ways of informing pilots when to be on which frequency, to ensure that pilots are always in communication with the correct controller at all points in the movement area," the report found.

The report also noted that there are no standard requirements for showing on airport diagrams exactly where aircraft pilots should switch frequencies from ramp to ground control. "Pilots needs to see this information on the diagrams for quick reference," the report said. "In addition, there are no standard conventions on when or where to switch from ground control to the tower frequency."

The MITRE researchers recommended that the FAA specify a standard way of showing, on airport diagrams, the sites where

aircraft pilots should switch from ramp control to ground control. The report also suggested that, at airports where the switch location comes before the departure runway, the FAA require that the information on where to switch from ground control to the tower frequency be included in charted, standard taxi routes.

Pilots also complained that having one controller working two separate frequencies can lead to missed calls, interrupted transmissions and unnecessary repetition of instructions.

Pilots transmitting on one frequency cannot hear the pilots on the other frequency. One pilot commented: "It amazes me how a controller can get upset and say, "Everybody listen up, I'm working two frequencies.' How do we know when someone is talking on another frequency when we're not listening to that frequency?"

Some pilots complain that, when separate frequencies with separate controllers are used for two local or two ground controls (or both), pilots lose the sort of "party line" communication that helped them hear instructions to and responses from other aircraft in the area.

At one eastern airport, a pilot wrote, "Intersecting landing runways are on different frequencies. This is an accident waiting to happen." Another pilot advised: "Controllers need to be limited to working just one frequency — not multiple [frequencies]. If we can hear both sides of the conversation, we can catch mistakes."

The report found that "one controller working two VHF radio frequencies for airport surface operations can compromise effective ATC-pilot communications. When two ATCT [air traffic control tower] control positions are combined, the controller is transmitting and listening on two frequencies, but the pilots are communicating on one or the other of the separate frequencies."

In such situations, the pilots do not know when other pilots are talking on the other frequency, leading to occasional simultaneous transmissions, which result "in incomplete or misunderstood communications." The report concluded that "there is a need to use a single VHF radio frequency when ATCT control positions are combined."

The report recommended that the FAA require ATCT facilities to let pilots know via the Automatic Terminal Information Service (ATIS) that "certain ground and local control positions are combined on the specified frequency."

"Controllers give the same clearance so many times that they become careless in their speech," a pilot wrote. "It is hard to enunciate a word as well the 10,000th time as it is the first."

Another pilot observed that "some controllers feel the quicker they can rattle off instructions, the better the controller they are. Most of the time this backfires ... because we have to take time to reconstruct his instructions ... or make another radio call." The pilot advised: "Slow it down a little, and you'll save time overall."

Reflecting the pilots' comments, the report found that "ATC-pilot communications are causing increasing difficulties for pilots ... . There is a great need to improve ATC communications over the voice radio frequencies so that ATC is not inadvertently contributing to pilot errors during operations on the airport surface."

Some controllers fail to use full call signs, and others use colloquial names for taxiways or landmarks that some pilots do not recognize. "At certain airports, controllers' word enunciation, accents or voice pitch further compounds the problem of hearing and understanding rapidly spoken instructions," the report said.

"Controllers need specific initial and refresher training in speaking on the radio frequencies at an understandable rate and enunciating the ATC terms in a nationally standard way."

In their comments, many pilots noted that they had problems understanding some controllers with unusual accents, or — in some cases — the higher-pitched voices of female controllers.

"I feel that speaking English fluently and without an accent should be required by all U.S. pilots and controllers," one pilot suggested. "At times, this is a big problem."

Another wrote: "Female controllers do excellent work controlling, but for some reason their voice quality — as received over the radio — is often harsh, staccato and irritating." Yet another pilot observed, "Some women controllers' voices become shrill and difficult to understand over VHF radios ... . Is there a way to moderate this shrillness by using microphones which wouldn't amplify this very annoying quality?"

The MITRE researchers agreed that "some women have high-pitched voices, which apparently are more difficult to understand on some radios." The report suggested that the FAA include voice pitch in its research on future radio equipment.

The report also suggested that the FAA controller training programs emphasize speech rates, word enunciation and standard accents, and make sure that "proper speech rate and word enunciation" are included in future refresher training for controllers.

"Nonstandard phraseology is inexcusable; yet it seems to be flagrant at our most complicated and congested airports," one pilot complained.

Another pilot said he had been surprised to find "a total lack of knowledge of the pilot/controller glossary for communications" among his airline's pilots. "Radio phraseology

has almost never been addressed by recurrent training," the pilot wrote.

While most controllers use standard phraseology, the report found that "pilot training in communicating with ATC is not as formally structured as controller training ... . These varied, nonstandard [pilot] responses make the controllers' task of confirming the pilots' readbacks more difficult. They place an unnecessary burden on the controllers ... ."

In the survey, one pilot observed that "a very disturbing readback by many pilots is the term, 'on the hold,' when given a position-and-hold clearance. It is not clear to others if that response means he is 'holding short' or intends to 'position and hold' on the runway."

The report, noting that "pilots do not have clear guidance on how to respond to ATC instructions," recommended that the airlines train their pilots and require them to use "appropriate ATC phraseology in all radio communications with ATC, reflecting the phraseology used by the controllers, and avoiding variations ... ."

The report also suggested that the FAA require both pilots and controllers to use full call signs or, at least, FAA-approved abbreviated call signs, in all radio communications between pilots and ATC.

Only a few of the pilots in the survey reported that they had received progressive [step-by-step at appropriate intervals] taxi instructions at unfamiliar airports. But between one-third and one-half of the pilots said they would have preferred getting such progressive instruction, if that had been possible.

"If taxi instructions are issued in progressive stages, this helps alleviate any problems the pilot may have with communication and memory," the report found. But the researchers also cautioned that "there is a conflict between issuing complex and precise taxi instructions in such a way that the pilot's task is easier ... and minimizing the use of the radio frequency."

The MITRE researchers observed that standard, charted taxi routes will solve some of the problems, as will plans to use a data link for taxi instructions. "Data link technology was available decades ago: Why aren't we using it?" commented a pilot.

The report recommended that the FAA "instruct controllers to limit ATC instructions to a few simple items at those times when pilots are busy maneuvering the aircraft or reconfiguring it after landing, and give further instructions in a second transmission," at a time when pilots have time to pay attention to them.

Improving cockpit procedures for airport surface operations. As airport surface operations have become increasingly complex in recent years, researchers found, "cockpit procedures and intracockpit communications have not changed to accommodate these evolving complexities and fast-paced ATC operations."

The report found no standard set of procedures for maintaining pilot orientation while taxiing at airports, or for verifying line-up on the correct runway. Pilots tend to develop their own procedures, which differ widely.

The report called for "development and implementation of structured and standardized cockpit crew procedures for surface operations," and formal training on their use.

For an aircraft to move safely on airport taxiways and runways, it is essential that both the captain and the first officer understand all ground-movement instructions from ATC. But researchers found "no structured, standardized procedures or formal training for intracockpit communications on ground-movement instructions and navigating on the airport surface."

The report recommended taking "a completely fresh look at what goes on in the cockpit during surface operations, and to redesign crew procedures and communications to better fit today's operations."

"Data link technology was available decades ago: Why aren't we using it?"

In developing new, standardized procedures, and in the formal training of pilots, the researchers noted three main obstacles:

- Because the cockpit workload already is high, new procedures and requirements "must be added through a careful integration of the new with the old, and through a reduction of other cockpit tasks where possible";

- Because, in two-pilot flight crews, the first officer is often unable to take part in the taxi process because he is monitoring the company frequency while the captain listens to ATC tower and ground control frequencies, "a way must be found to include the FO actively at specific critical points in the process"; and,

- Because airports differ so much, and ATC operations vary considerably depending on the time of day even at the same airport, the new procedures and crew-communication rules for the taxi process must be flexible.

On the principle that enhanced crew teamwork and verbal coordination will reduce the potential for pilot errors at airports, the report recommended that airlines "develop and implement structured cockpit procedures and communications for verbal coordination between crew members ... ."

The MITRE researchers suggested that the new procedures for verbal coordination should include pretaxi and prelanding

briefings for planned airport-surface operations; verbal exchange of, and agreement on, the runway and taxi route assigned by ATC and operational procedures; and cockpit communications to help negotiate complex intersections, cross runways and use runways for takeoff or landing.

At present, the airlines' training of pilots for airport-surface operations mostly tends to emphasize cockpit "flows" and checklists, the report said.

The report recommended additional training "to ensure that pilots understand the need for and use of verbal coordination ... and how it is integrated with other cockpit tasks."♦

Editorial note: This article was adapted from *Reports By Airline Pilots on Airport Surface Operations,* a special report by Glennis L. Adam, David R. Kelley and J. Glenn Steinbacher of the MITRE Corp., prepared for the U.S. Federal Aviation Administration. Contract No. DTFA01-93-C-0001. May 1994.

The report is divided into four volumes: the 121-page Part One, *Identified Problems and Proposed Solutions for Surface Navigation and Communications;* the 28-page Executive Summary; the 29-page Abridged Version; and the 202-page *Appendixes to Reports By Airline Pilots on Airport Surface Operations*, which includes numerous charts. Other reports will be published later based on different parts of the pilot questionnaire.

References*

1. U.S. National Transportation Safety Board. *Special Investigation Report, Runway Incursions at Controlled Airports in the United States.* Report No. NTSB/SIR-86/01. 1986.

2. Kelley, D.R.; Steinbacher, J.G. *Pilot Surface Incident Safety Study.* Report No. MTR-920000116. McLean, Virginia, U.S.: The MITRE Corp., 1993.

3. Hill, J.G. *A Human Factors Analysis of 504 Runway Incident Investigations.* Report No. MTR-93W0000007. McLean, Virginia, U.S.: The MITRE Corp., 1993.

*The original report cited 20 references.

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