Office of Inspector General

Audit Report

ENHANCED FAA OVERSIGHT COULD REDUCE HAZARDS ASSOCIATED WITH INCREASED USE OF FLIGHT DECK AUTOMATION

Federal Aviation Administration

Report Number: AV-2016-013
Date Issued: January 7, 2016

Memorandum

U.S. Department of Transportation
Office of the Secretary
of Transportation
Office of Inspector General

Subject: **ACTION:** Enhanced FAA Oversight Could Reduce Hazards Associated With Increased Use of Flight Deck Automation
Federal Aviation Administration
Report Number AV-2016-013

Date: January 7, 2016

From: Matthew E. Hampton
Assistant Inspector General
for Aviation Audits

Reply to Attn. of: JA-10

To: Federal Aviation Administrator

Advances in aircraft automation have significantly contributed to safety and changed the way airline pilots perform their duties—from manually flying the aircraft to spending a majority of their time monitoring flight deck systems. While airlines have long used automation safely to improve efficiency and reduce pilot workload, several recent accidents, including the July 2013 crash of Asiana Airlines flight 214, have shown that pilots who typically fly with automation can make errors when confronted with an unexpected event or transitioning to manual flying.[1] As a result, reliance on automation is a growing concern among industry experts, who have also questioned whether pilots are provided enough training and experience to maintain manual flying proficiency.

Given these concerns, the former Ranking Members of the House Transportation and Infrastructure Committee and its Subcommittee on Aviation requested that we evaluate the effectiveness of the Federal Aviation Administration's (FAA) oversight of pilot training for using and monitoring automated flight deck systems. Accordingly, our audit objectives were to (1) determine whether FAA has established requirements governing the use of flight deck automation and (2) identify FAA's process for ensuring that air carrier pilots are trained to use and monitor these systems while also maintaining proficiency in manual flight operations.

[1] Asiana Airlines Flight 214 crashed short of a runway at San Francisco International Airport, CA. The National Transportation Safety Board (NTSB) determined that the crew did not appropriately understand the aircraft's automation systems, allowed airspeed to decay due to improper monitoring, and failed to perform a proper go-around response.

To conduct our work, we interviewed FAA officials responsible for aviation safety and pilot training. We also visited nine randomly selected Part 121[2] air carriers representing both large and small operations and their respective FAA oversight offices. We conducted our work in accordance with generally accepted Government auditing standards. Exhibit A details our scope and methodology, and exhibit B lists the organizations we visited or contacted.

RESULTS IN BRIEF

FAA has established certain requirements governing the use of flight deck automation during commercial operations. In particular, FAA has developed limitations regarding minimum altitudes at which autopilot can be engaged and how automated systems within the cockpit are configured to provide ease of use. For example, during takeoff and climb below 500 feet, FAA restricts the use of autopilot unless the carrier is granted explicit FAA authorization to use it sooner. In addition, FAA requires that pilots be trained, tested, and proficient in all aircraft they operate, including any onboard automated flight deck systems. Further, air carriers must obtain FAA authorization in order to use certain advanced flight procedures that rely on automation. Of the nine carriers we visited, six requested and received FAA authorization to use advanced procedures. FAA requirements promote safety and provide a basis to oversee the use of flight deck automation while maintaining flexibility for different aircraft and systems. This is important because FAA estimates that automation is used 90 percent of the time in flight.

However, FAA does not have a process to ensure that air carrier pilots are trained to use and monitor automation systems while also maintaining proficiency in manual flight operations. First, the Agency has not ensured that air carrier training programs adequately address pilots' ability to monitor the flight path, systems, and the actions of other crewmembers—commonly referred to as pilot monitoring. For example, only 5 of 19 simulator training plans we reviewed specifically mentioned pilot monitoring. Second, FAA is not well positioned to determine how often air carrier pilots manually fly aircraft and has not ensured that air carrier training programs adequately focus on manual flying skills. In January 2013, FAA issued a safety alert[3] to air carriers encouraging them to promote manual flight opportunities in both aircraft operations and training. While using these skills is recognized as a best practice for pilots to maintain manual proficiency, FAA has not determined whether air carriers have increased manual flying opportunities as a result of issuing its recommendation to the industry. Third, FAA has not ensured that air carrier training programs adequately focus on manual flying skills. In

[2] 14 CFR Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations.
[3] Safety Alert for Operators (SAFO) 13002 – Manual Flight Operations, January 4, 2013.

2013, FAA published a pilot training rule[4] to enhance pilot monitoring and manual flying skills. The Agency is currently developing guidance for implementing the new training requirements, but a completion date has not been determined and air carriers are not mandated to comply with it until 2019. Because FAA has not determined how carriers should implement new requirements or evaluated whether pilots manual flying time has increased, the Agency is missing important opportunities to ensure that pilots maintain skills needed to safely fly and recover in the event of a failure with flight deck automation or an unexpected event.

We are making recommendations to enhance FAA's ability to ensure that air carriers sufficiently address pilot monitoring and manual flying skills.

BACKGROUND

As technology has evolved, so have automation capabilities on commercial airline flight decks. Generally, new automation technologies are added to gain operational or efficiency advantages, such as reducing pilot workload, adding more capability, increasing fuel economy, and allowing access to airports surrounded by challenging terrain. Similarly, the flight deck design has changed to streamline the presentation of aircraft information and reduce the number of individual gauges that must be monitored during flight. Figure 1 below shows the advances in flight deck technology between Boeing 737-200 (pictured left) and modern 737 aircrafts (pictured right). To a large extent, these goals have been achieved, and the industry and flying public have benefited from increased amounts of highly reliable automation.

Figure 1. Evolution of Boeing 737 Flight Decks

Source: The Boeing Corporation

[4] Final Rule published November 12, 2013: "Qualification, Service, and Use of Crewmembers and Aircraft Dispatchers."

Modern commercial aircraft are typically operated using auto-flight systems (e.g., autopilot or auto-throttle[5]). While these systems have been available on commercial aircraft for decades, early versions required pilots to directly input commands into the autopilot to control the aircraft. On today's aircraft, flight information can be uploaded or pilots can program it into the flight management system. This allows the automation to control the aircraft through most phases of flight—from just after take-off until the plane lands at the airport.

As shown in table 1, there are multiple levels of automation that pilots may use, ranging from strictly manual flight to highly automated. While no single level of automation is appropriate for all flight environments, it is important that pilots have a good understanding of the system and make the appropriate decisions when encountering unusual situations, such as when automation fails or there is an emergency.

Table 1. Levels of Flight Deck Automation

Level	Auto-pilot Engaged	Auto-throttle Engaged	Overview
Full Auto-flight	X	X	The aircraft's control is fully automated based on information preprogrammed by the pilots.
Tactical Auto-flight	X	X	The aircraft's autopilot is engaged, but pilots can direct changes to heading, speed, and altitude using a control panel.
Manual		X	The pilot is manually controlling the aircraft based on guidance assistance from the preprogrammed flight directors. This is primarily used for takeoff, initial departure and landings.
All Automation Off/Full Manual			The pilot is manually controlling the aircraft without the assistance of flight directors. This would be used to avoid collisions with other aircraft or to recover from an undesired aircraft state such as a stall.

Source: OIG analysis of air carrier and manufacturer data

Concerns about the effects of automation are not new. In fact, FAA reported on the interface of flight crews and aircraft automation in 1996 and again in November 2013.[6] The 2013 report from the Flight Deck Automation Working Group identified vulnerabilities in pilots' manual flying skills, awareness of aircraft speed and altitude, and reliance on automation, among other findings.

[5] Autopilot is an electronic control system on aircraft that automatically maintains a preset heading and altitude. Auto-throttles automatically control the power setting of an aircraft's engines—controlling speed, rather than manually controlling the fuel flow.

[6] FAA Human Factors Team Report, *The Interfaces Between Flightcrews and Modern Flight Deck System*s, June 18, 1996. Performance Based Operations Aviation Rulemaking Committee and the Commercial Aviation Safety Team Working Group report, *Operational Use of Flight Path Management Systems*, September 5, 2013.

In addition, effective pilot monitoring is key to maintaining safety when using automated systems. For many years, aircraft accident data has shown that flight deck monitoring plays an important role in ensuring safety. For example, a 1994 National Transportation Safety Board (NTSB) study identified pilot monitoring errors in 31 of 37 (84 percent) U.S. airline accidents[7] reviewed. Accordingly, properly performing pilot monitoring may break the chain of events leading to an accident.

FAA HAS ESTABLISHED REQUIREMENTS GOVERNING THE USE OF FLIGHT DECK AUTOMATION

FAA has established some requirements governing the use of flight deck automation in commercial operations. However, FAA does not require pilots to use automation; according to an Agency official, it would be unrealistic to do so considering each aircraft has varying capabilities. For example, some smaller regional jets (e.g., CRJ-200) often do not have auto throttles, which are common on larger aircraft to maintain airspeed and reduce pilot workload. Instead, FAA requires that pilots be trained, tested, and proficient to fly whatever type of aircraft they operate, including the use of automation based on the manufacturer and airline requirements.

In addition, FAA has restrictions on pilots' use of autopilot during flight. Specifically, FAA regulations establish minimum altitudes at which autopilot can be engaged for different phases of flight. For example, pilots cannot use autopilot for takeoff or initial climb below 500 feet—unless a lower altitude is specified in the aircraft's operating manual and approved by FAA.[8] To maintain safety, FAA also has requirements for configuring automated systems in the cockpit, such as installation of quick autopilot disengagement controls.

Furthermore, FAA's policies require that specific types of automation must be functional on aircraft for certain advanced procedures. For example, air carriers must have approved flight management systems installed and operable to obtain approval for more efficient departures and arrivals, but carriers determine how their pilots use the automation when performing those procedures. Of the nine carriers we visited, six requested and received FAA authorization to use advanced procedures.

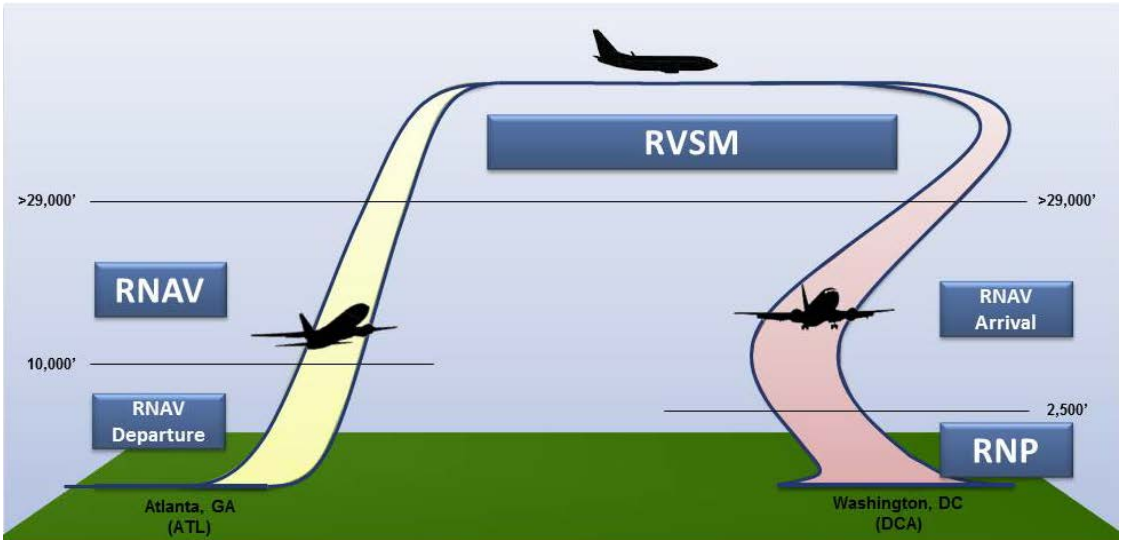
FAA and industry are transitioning to new flight procedures that use these advanced automated systems with satellite navigation to provide benefits such as

[7] NTSB Safety Study, *A Review of Flightcrew-Involved Major Accidents of U.S. Air Carriers, 1978-1990,* January 1994.

[8] OpSpec C071, Autopilot Minimum Use Altitudes/Heights, was published to authorize air carriers to engage autopilot at an altitude lower than 500 feet after takeoff, effective February 3, 2014.

safer, more efficient operations and greater airspace capacity.[9] For example, pilots are increasingly using automated systems for Area Navigation (known as RNAV), a method of flying in which aircraft use satellite signals to fly any desired flight path without the limitations imposed by ground-based navigation systems. In addition, Required Navigation Performance (RNP) procedures are a form of RNAV that adds monitoring and alerting capabilities for pilots that allow aircraft to fly more precise flight paths. These procedures (as shown in figure 2), combined with air carrier requirements to use autopilot to maintain aircraft separation requirements (known as RVSM),[10] demonstrate the increasing significance of automation across all phases of flight.

Figure 2. Example of Advanced Flight Procedures – Atlanta, GA, to Washington, DC



Source: OIG analysis of FAA flight procedures

As use of automation increases, pilots have fewer opportunities to use manual flying skills. To date, FAA has implemented over 1,550 of these automated procedures. In addition, from 2010 to 2013, 7 of the Nation's 10 busiest airports significantly increased the number of RNAV arrival procedures used. FAA and industry are continually working to modernize the National Airspace System and expect deployment and use of advanced procedures using flight deck automation to increase. As a result, the opportunities air carrier pilots have during live operations to maintain proficiency in manual flight are limited and are likely to diminish.

[9] For additional details on FAA and industry efforts to advance new performance based navigation procedures, see our report entitled *FAA Faces Significant Obstacles in Advancing the Implementation and Use of Performance Based Navigation Procedures* (OIG Report No. AV-2014-057), June 17, 2014. OIG reports are available on our Web site at http://www.oig.dot.gov/.

[10] Reduced Vertical Separation Minimum (RVSM) was implemented to reduce the vertical separation above 29,000 ft. from 2,000 ft. minimum to 1,000 ft. It allows aircraft to safely fly more optimum profiles, gain fuel savings and increase airspace capacity.

FAA LACKS AN EFFECTIVE PROCESS TO ASSESS HOW PILOTS MONITOR AIRCRAFT PERFORMANCE AND MAINTAIN MANUAL FLYING SKILLS

FAA does not have a sufficient process to assess a pilot's ability to monitor flight deck automation systems and manual flying skills, both of which are important for handling unexpected events during flight. In addition, FAA is not well positioned to determine how often air carrier pilots manually fly aircraft. FAA has also not ensured that air carrier training programs adequately focus on manual flying skills.

FAA Has Not Ensured Air Carriers Adequately Train and Evaluate Pilot Monitoring Skills

Because many pilots use automation in most phases of flight, their ability to effectively perform monitoring duties is critical to maintaining safety. Pilot monitoring consists of a pilot carefully observing the aircraft's flight path, automation modes, and on-board systems and actively cross-checking the actions of other crew members. Ineffective pilot monitoring has been a factor in several recent aviation accidents. For example, in the August 2013 crash of UPS flight 1354, NTSB found that both pilots failed to monitor the aircraft's altitude during the final approach into Birmingham-Shuttlesworth International Airport.[11]

Despite the importance of pilots' monitoring skills, FAA does not have effective processes to assess these skills both in training and during flight. According to FAA, pilots' monitoring skills are evaluated through current testing standards. However, the standards only require that pilots monitor certain items during the take-off and approach phases of flight, such as monitoring engine settings and the status of navigation equipment. Further, FAA inspectors told us they did not know how to assess a pilot's ability to monitor the state of the aircraft, beyond observing call-outs (i.e., when a pilot verbally communicates an action that was taken or becomes aware of various conditions during flight). While call-outs are crucial, industry experts state that there are also other methods to assess monitoring skills. Some of these methods include measuring pilots' ability to detect changes to the autopilot settings or deviations from the flight path and to prioritize non-essential tasks during certain phases of flight.

In addition, joint government and industry studies have identified pilot monitoring as an area where air carriers can improve their training and evaluation programs (see table 2).

[11] NTSB Accident Report, *Crash During a Nonprecision Instrument Approach to Landing UPS Flight 1354, Airbus A300-600, N155UP, Birmingham, Alabama August 14, 2013*, NTSB/AAR-14/02.

Table 2. Findings and Recommendations From Studies on Pilot Monitoring

	Findings	Recommendations
2014 CAST Airplane State Awareness study[12]	• In many of the accidents and incidents reviewed, pilots failed to properly perform monitoring duties.	• Air carriers should enhance communication between pilots and provide training on active monitoring roles—with emphasis on detecting, challenging, and correcting pilot errors.
2014 Flight Path Monitoring[13]	• Investigations, flight deck observations, and safety data have shown that monitoring problems play a significant role in aviation accidents. • Training programs are important to help a pilot effectively monitor all phases of flight.	• Air carriers must develop clearly defined monitoring tasks and proficiency standards that could be trained and evaluated.

Source: OIG analysis

Both studies identified above found that in many of the accidents and incidents they reviewed, the pilot failed to properly monitor the state of the aircraft during flight. Despite these findings, FAA has not ensured that pilot monitoring is adequately addressed in air carrier training programs. Only 5 of 19 initial simulator training plans we reviewed specifically mentioned pilot monitoring.

Many air carriers address a pilot's ability to monitor flight deck automation systems through crew resource management (CRM) training, but this training alone does not fully address pilot monitoring duties. CRM training emphasizes leadership and decision making in the cockpit and has been promoted by FAA since the 1970s, but it is not an alternative to specific pilot monitoring training. Eight of the nine air carriers we visited used CRM lessons to address pilot monitoring during training. However, the 2014 Flight Path Monitoring report stated that while CRM training often focuses on the prioritization and distribution of crewmember workloads, it provides little guidance "for how to manage attention when juggling concurrent task demands." In addition, NTSB's accident report for Colgan flight 3407[14] concluded that the monitoring errors made by the flight crew demonstrated the necessity for specific pilot training on active monitoring skills—skills that were not addressed in the carrier's CRM program.

[12] The Airplane State Awareness Joint Safety Implementation Team Final Report; June 17, 2014.
[13] *A Practical Guide for Flight Path Monitoring, Active Pilot Monitoring Working Group*, November 2014.
[14] NTSB Accident Report, *Loss of Control on Approach, Colgan Air, Inc. Operating as Continental Connection Flight 3407 Bombardier DHC-8-400, N200WQ Clarence Center, New York; February 12, 2009*, NTSB/AAR-10/01.

Although FAA recently issued new training standards, the new standards do not ensure active pilot monitoring skills are specifically assessed during proficiency evaluations. FAA's 2013 pilot training rule addressed pilot monitoring, but did not require carriers to evaluate a pilot's performance in this area. In response to comments received on the proposed rule, FAA stated it would be inappropriate to require it as a standalone training event. The rule does require, however, that the pilot who is not flying the aircraft monitor the aircraft's operation. In addition, carriers must incorporate pilot monitoring into their flight procedures and simulator training sessions designed to represent normal flight operations.

Further, FAA has yet to issue guidance clarifying what actions are needed to comply with the rule, such as providing metrics that carriers can use to train and evaluate pilots' monitoring skills. FAA is currently researching and developing standards for monitoring, which could lead to metrics to evaluate pilot skills. However, these standards, and any subsequent metrics, are years away from implementation. NTSB recommended that FAA require all pilot training programs to teach and emphasize pilot monitoring and work management skills. In addition, the Flight Path Monitoring Report recommended that air carriers clearly define tasks and standards that could be trained and evaluated because those involved with this study believe that pilots will focus on skills on which they will be evaluated. Because FAA does not require pilots to be evaluated on monitoring skills, pilots may not recognize its importance and safety benefits.

FAA Lacks a Process To Determine How Often Pilots Use Manual Flying Skills

FAA does not have a method for determining how often pilots use manual flying skills. Proficiency in manual flying is critical for ensuring that pilots can safely fly a plane in the event of an automation failure or other unexpected event. Improvements in the design, training, and operational use of automated systems have contributed to the Nation's impressive safety record. However, these improvements may be contributing to diminished manual flying skills due to an increased reliance on automation.

Several recent studies have highlighted the challenges that pilots face in maintaining manual flying proficiency, as shown in table 3.

Table 3. Findings and Recommendations From Studies on Manual Flying of Aircraft

	Findings	Recommendations
2010 Flight Safety Foundation Study[15]	• On a 5-point scale, where pilots needed a 4 to meet FAA's standards, pilots had average scores ranging from a high of 3.2 for take-offs to a low of 2.4 on flying holding patterns—both well below FAA standards. • The results were attributed in part to declines in the pilots' manual flight skills, coupled with the pilots' over-estimating their own manual proficiency. • Pilots' basic instrument skills can decline over time.	• Ensure airline pilots are competent not only when automation is functioning, but when instrumentation fails. • Pilots' skills can be increased through training and practice.
2011 Pilot Training Rulemaking Committee	• Increased availability of advanced generation automation has greatly increased the crew's ability to more precisely control the aircraft's flight path. • Increased automation, along with desire to maximize limited airspaces, has led to requirements for operators to equip, train, and use automation in place of traditional hand flying.	• Encourage air carriers to provide guidance for manual flying due to the limited opportunities for pilots to maintain these skills.
2013 NASA Study[16]	• Pilots were presented with abnormal events under highly scripted, predictable circumstances often used in airline training and under less predictable conditions; similar to what they would encounter in a real flight. • The study found that the responses to abnormal in-flight events learned and practiced during airline training may not generalize well to real flight settings and experiences.	• Pilots should "turn off the automation" in training so that they can better learn how to identify abnormal situations without automation's assistance/alerts.

[15] Flight Safety Foundation. Gillen, Michael W. "Diminishing Skills?" *AeroSafetyWorld* July, 2010
[16] "The Effectiveness of Airline Pilot Training for Abnormal Events" *Human Factors* Vol. #55, No. 3; June, 2013

	Findings	Recommendations
2013 Flight Deck Automation Working Group[17]	• Working group identified vulnerabilities in pilot knowledge and skills that have resulted in increased manual handling errors.	• FAA should develop and implement standards/guidance to maintain and improve knowledge and skills for manual flight including: (a) opportunities for pilots to refine knowledge and practice skills, (b) training and checking, and (c) flight path management policies on the aircraft type.
2014 NASA Study[18]	• Pilots sometimes struggled to maintain the cognitive skills that accompany manual flying such as awareness of the aircraft's position and recognizing instrument system failures.	• Pilots could benefit from additional practice of manual flying skills. • The study promoted the use of more active automation monitoring practices.

Source: OIG analysis

A common thread among all these studies and reviews is that pilots could benefit from additional time manually flying aircraft. However, air carriers may not know how often their pilots have the opportunity to manually fly. For example, only two of the nine carriers we visited analyzed data to determine the extent pilots are using autopilot in daily operations. Senior FAA officials estimate that airline pilots use automated systems 90 percent of the time, but stated there is no industry-wide analysis to validate this estimate.

Further, studies have concluded that pilots may overestimate their manual flying skills. For example, the Flight Safety Foundation's 2010 study evaluated the manual flying skills of 30 experienced U.S. commercial airline pilots. While 80 percent of the pilots reported that they typically hand fly the aircraft below 10,000 feet, the pilots' aggregate scores for manual flying maneuvers fell below FAA's standards for these pilots. Despite the pilots' stated manual flight experience, they were not able to meet the standards using only basic instrumentation that would be available if an automation failure occurred during flight.

Finally, air carriers do not consistently require pilots to use and maintain manual flying skills in different aspects of flight. In January 2013, FAA issued a safety

[17] The Flight Deck Automation Working Group was a joint working group established by the Performance-Based Aviation Rulemaking Committee (PARC) and the Commercial Aviation Safety Team (CAST) to address the safety and efficiency of modern flight deck systems for flight path management.
[18] The Retention of Manual Flying Skills in the Automated Cockpit, *Human Factors*. Vol.56, No. 8; December 2014.

alert[19] to air carriers encouraging them to promote manual flight opportunities in both aircraft operations and training. This was largely in response to concerns raised by the 2011 Pilot Training Rulemaking Committee and the 2013 Flight Deck Automation Working Group, including concerns that pilots rely too much on automation and may not be prepared to handle non-routine situations. However, we found two of nine carriers we visited discouraged pilots from manual flying under normal conditions. For example, one carrier directed pilots to "fly the aircraft with the highest level of automation" and restrict hand-flying to "low-threat" environments." This policy appears to reflect FAA's recommendation; however, senior management at this carrier told us their pilots rarely, if ever, fly in such environments. If operational requirements and policies do not support manual flying, pilots may have difficulty maintaining the skills needed to handle non-routine situations.

Industry experts recognize that using hand-flying skills is a best practice for pilots to maintain manual flying proficiency. However, FAA has not provided guidance to its inspectors on how to evaluate whether pilots have sufficient opportunities to practice these critical skills. As a result, air carrier policies in this area remain inconsistent.

FAA Has Not Ensured That Air Carrier Training Programs Adequately Focus on Manual Flying Skills

FAA does not have a process to determine whether air carrier training programs provide adequate opportunities for pilots to maintain manual flying skills. As manual flying opportunities during normal operations have diminished, air carriers have not fully adjusted their training programs to address possible vulnerabilities in pilots' manual proficiency. In 2014, a National Aeronautics and Space Administration (NASA) study examining the retention of manual flying skills found that pilots could benefit from additional manual flying practice during flight or recurrent training, especially since pilots sometimes struggled to maintain an awareness of the aircraft's position and recognize instrument system failures. However, FAA has not provided guidance to inspectors and does not require them to evaluate training programs and policies to determine whether pilots are maintaining manual flying skills. As a result, FAA cannot be assured that pilots receive sufficient opportunities to develop, maintain, and demonstrate manual flying skills.

FAA and air carriers are also not tracking which training exercises are performed manually compared with those performed using automation. Further, none of the initial flight simulator training programs we reviewed at nine air carriers identified the amount of time pilots were required to train on manual flying skills. We also

[19] Safety Alert For Operators (SAFO) 13002 – Manual Flight Operations, January 4, 2013.

identified significant differences regarding the emphasis placed on manual flying in training. For example, one carrier emphasized hand-flying for the First Officer, who typically has less flying time than the Captain. In comparison, another carrier encouraged crews to use full automation during simulator training. The latter approach may limit opportunities for pilots to maintain adequate knowledge and comfort with manual flying. The significance of training pilots on manual flying was reiterated by Airbus' 2014 announcement that it developed a training plan for its new A350 aircraft that allocates the first simulator session to manual flying so pilots can learn how to control the aircraft before introducing automation. These changes were prompted by the growing realization that pilots may be losing their manual flying skills.

FAA has established training and evaluation requirements to ensure manual proficiency in takeoffs, landings, and abnormal events. However, these requirements allow for the use of varying levels of automation, and some pilots we interviewed told us they rarely use the lowest levels of automation during training. For example, one pilot we interviewed, who is authorized to conduct pilot evaluations on behalf of FAA, told us that most pilots "turn on the autopilot as soon as they can" during evaluations so as to minimize the potential for error during a graded event. As a result, FAA cannot be assured pilots can perform these requirements without the use of automation.

Recognizing the importance of training for manual flying skills, FAA's new pilot training rule required increased manual flying maneuvers for pilots (see table 4).

Table 4. New Manual Flying Simulator Training Requirements for 2019

Training Maneuvers	Overview
Upset Prevention and Recovery	Aircraft upset is an unsafe condition which may result in loss of control (LOC). Training should focus on the pilot's manual handling skills to prevent upset, as well as training to recover from this condition.
Manually Controlled Arrival and Departure	Pilots will be both trained and evaluated on their ability to manually fly a departure sequence and arrival into an airport.
Slow Flight	Pilots will be trained to understand the performance of the aircraft and the way it handles at airspeeds just above the stall warning.
Loss of Reliable Airspeed	Training will focus on the recognition and appropriate response to a system malfunction that results in a loss of reliable airspeed which increases risk of aircraft stall and/or upset.

Training Maneuvers	Overview
Recovery from Stall/Stickpusher Activation	Training will provide pilots the knowledge and skills to avoid undesired aircraft conditions that increase the risk of encountering a stall or, if not avoided, to respond correctly and promptly.
Recovery from Bounced Landing	A poorly executed approach and touchdown can generate a shallow bounce (skip) or a high, hard bounce that can quickly develop into a hard landing accident.

Source: OIG analysis

However, air carriers are not required to comply with these new requirements until 2019. FAA is currently developing guidance for implementing the new training requirements but a completion date has not been determined. As a result, air carriers and FAA inspectors are unsure as to what changes are needed to comply with the new training requirements.

CONCLUSION

Maintaining the safety of the National Airspace System depends on ensuring pilots have the skills to fly their aircraft under all conditions. Relying too heavily on automation systems may hinder a pilot's ability to manually fly the aircraft during unexpected events. While FAA has taken steps to emphasize the importance of pilots' manual flying and monitoring skills, the Agency can and should do more to ensure that air carriers are sufficiently training their pilots on these skills. In particular, FAA has opportunities to improve its guidance to inspectors for evaluating both air carrier policies and training programs. These improvements can help ensure that air carriers create and maintain a culture that emphasizes pilots' authority and manual flying skills.

RECOMMENDATIONS

To enhance FAA's ability to ensure that air carriers sufficiently address pilot monitoring and manual flying skills, we recommend that the Federal Aviation Administrator:

1. Develop guidance defining pilot monitoring metrics that air carriers can use to train and evaluate pilots.

2. Develop standards to determine whether pilots receive sufficient training opportunities to develop, maintain, and demonstrate manual flying skills.

AGENCY COMMENTS AND OFFICE OF INSPECTOR GENERAL RESPONSE

We provided FAA a copy of our draft report on November 9, 2015, and received its response on December 4, 2015, which is included as an appendix to this report. FAA partially concurred with recommendation 1 and concurred with recommendation 2 as written. We are requesting that FAA clarify its responses for both recommendations.

FAA partially concurred with recommendation 1. The Agency proposes developing guidance defining pilot monitoring duties and responsibilities that air carriers can use to develop a pilot monitoring training curriculum. While defining pilot monitoring duties and responsibilities is important, we believe it is critical that FAA also develop metrics or measurable tasks that air carriers can use to evaluate pilot monitoring proficiency. Therefore, FAA's response does not meet the full intent of our recommendation. As a result, we consider this recommendation open and unresolved pending additional information from FAA.

In response to recommendation 2, FAA concurred, stating its 2013 pilot training rule contains additional manual flying requirements. However, FAA did not state how it determined that the additional requirements will give pilots sufficient opportunities to maintain and demonstrate manual flying skills. These skills are necessary to ensure pilots can recover from an unexpected event or failures with highly automated cockpit systems, which was the main focus of our recommendation. Accordingly, we consider recommendation 2 open and unresolved and request FAA clarify its planned actions to address our recommendation.

ACTIONS REQUIRED

We consider recommendations 1 and 2 open and unresolved pending additional information from the Agency. In accordance with DOT Order 8000.1C, we request that FAA provide this additional information within 30 days of this report.

We appreciate the courtesies and cooperation of FAA representatives during this audit. If you have any questions concerning this report, please call me at (202) 366-0500 or Tina Nysted, Program Director, at (404) 562-3770.

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cc: DOT Audit Liaison, M-1
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EXHIBIT A. SCOPE AND METHODOLOGY

We conducted this review between March 2014 and November 2015 in accordance with generally accepted Government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. Our audit objectives were to (1) determine whether FAA has established requirements governing the use of flight deck automation and (2) identify FAA's process for ensuring that air carrier pilots are trained to use and monitor these systems while also maintaining proficiency in manual flight operations.

To determine FAA's current policies on automation and manual flight, we reviewed Federal aviation rules and Agency guidance to inspectors and air carriers. We also interviewed FAA officials to determine the amount of automation used in commercial airline operations, and how the Agency provided oversight for the use of flight deck automation. In addition, we obtained and analyzed data from MITRE to determine the usage of high precision approaches and departures, which utilize automation, across major airports.

To identify FAA's process for ensuring that air carrier pilots are trained to use and monitor automated systems while maintain manual flying proficiency, we randomly selected 9 out of 81 Part 121 and Part 121/135 carriers and interviewed their management about policies and training programs regarding automation, manual flying, and pilot monitoring. To review the extent of pilot monitoring training we obtained 19 of 24 initial full flight simulator (FFS) training documents for aircrafts operated by these carriers. We did not review five aircraft training documents because they were not comparable to programs from other carriers within our sample. At eight of the nine carriers we also interviewed pilots based on their role as a first officer, captain, or check airman. We also interviewed the respective FAA Certificate Management Teams tasked with overseeing those nine carriers to determine how they oversee manual flying proficiency and pilot monitoring at the field level. In addition, we interviewed representatives from NTSB, an aircraft manufacturer, and two industry groups regarding pilot monitoring and the use of automation in commercial airline operations.

The scope of work on internal controls was limited to gaining an understanding of FAA oversight pilots' use of flight deck automation. Deficiencies identified are included in the report.

EXHIBIT B. ORGANIZATIONS VISITED OR CONTACTED

Federal Aviation Administration (FAA) Headquarters

Aircraft Certification Service	Washington, DC
Air Carrier Training Systems	Washington, DC
Policy Integration Branch	Washington, DC
Discovery and Safety Measurements Programs	Washington, DC

FAA Flight Standards District Offices (FSDO)

Minneapolis FSDO	Minneapolis, MN
Charlotte FSDO	Charlotte, NC
East Michigan FSDO	Belleville, MI

FAA Certificate Management Offices (CMO)

Dallas/Fort Worth CMO	Irving, TX
United CMO	Des Plaines, IL
Alaska CMO	SeaTac, WA
Phoenix CMO	Phoenix, AZ

Air Carriers

Omni Air	Tulsa, OK
Alaska Airlines	Seattle, WA
Endeavor Air	Minneapolis, MN
US Airways	Charlotte, NC
United Airlines	Denver, CO
Kalitta Charters II	Ypsilanti, MI
USA Jet	Belleville, MI
Swift Air	Phoenix, AZ
Mesa Airlines	Phoenix, AZ

Other Organizations

Boeing Flight Services	Miami, FL
Air Line Pilots Association	Washington, DC
Airlines for America	Washington, DC
National Transportation Safety Board	Washington, DC

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Federal Aviation Administration

Memorandum

Date: December 4, 2015

To: Matthew E. Hampton, Assistant Inspector General for Aviation Audits

From: H. Clayton Foushee, Director, Office of Audit and Evaluation, AAE-1

Subject: Federal Aviation Administration Response to Department of Transportation Office of Inspector General (OIG) Draft Report: Flight Deck Automation

The FAA shares the OIG's concerns about an over-reliance on automation and the importance of training pilots to handle unexpected events and manually fly an aircraft. As part of its ongoing efforts to enhance safety and put the best qualified and trained pilots in the flight decks of U.S. aircraft, the FAA issued a final rule in November 2013, *Qualification, Service and Use of Crewmembers and Aircraft Dispatchers*, that significantly advanced the way commercial air carrier pilots are trained.

The final rule requires:

- Ground and flight training that enables pilots to prevent and recover from aircraft stalls and upsets. These new training standards will impact future simulator standards as well.
- Air carriers to use data to track remedial training for pilots with performance deficiencies, such as failing a proficiency check or unsatisfactory performance during flight training.
- Enhanced runway safety procedures.
- Expanded crosswind training, including training for wind gusts.

In January 2014, the FAA established the Air Carrier Training Aviation Rulemaking Committee (ACT ARC) to provide a forum for the U.S. aviation community to discuss, prioritize, and provide recommendations to the FAA concerning operations and training conducted under Title 14 of the Code of Federal Regulations (14 CFR) parts 121, 135, and 142. The ACT ARC Steering Committee includes organizations that represent the industry for pilot, flight attendant, and dispatcher training across part 121 air carriers, part 135 air carriers and operators, and part 142 training centers. Additionally, air carriers are also developing safety management systems which will help air carriers identify and mitigate risks unique to their own operating environments.

The FAA concurs with OIG recommendation 2 as written, and partially concurs with recommendation 1. With regard to recommendation 1, the FAA does not concur with the development of metrics as the basis for training. However, the FAA will develop guidance defining pilot monitoring duties and responsibilities that air carriers can use to develop pilot

training and evaluation. The guidance will address the definition of pilot monitoring in the operational environment, and it will provide the basis for development of a curriculum and syllabus by carriers. The FAA plans to complete this action prior to January 31, 2017.

For recommendation 2, the FAA believes in, and has always required, the training, maintenance and evaluation of manual flying skills and the Agency has taken action to enhance those requirements. The recently published *Qualification, Service and Use of Crewmembers and Aircraft Dispatchers* final rule addresses this recommendation by including additional manual flying requirements, including training in the prevention and recovery from stalls and upsets, manually flown slow flights and manually flown arrivals and departures, and reinforces this training through checking. The implementation date for the pilot training portion of the rule is November 30, 2018.

The Agency appreciates the opportunity to offer additional perspectives on the OIG draft report. Please contact H. Clayton Foushee at (202) 267-9000 if you have any questions or require additional information regarding these comments.