KALITTA CHARTERS

# THE CHARTERS SAFETY CHRONICLE

4th Quarter 2021

## OUT OF CONTROL

*[Ed: The following article is quite lengthy, but well worth your time to read. Loss of control inflight has become the single leading cause of fatal accidents in our industry. Saying that it can't happen to you is not realistic. It can happen to anyone.]*

In the last decade, loss of control– inflight (LOC-I) has become the leading cause of fatalities in commercial aviation worldwide. A subcategory, flight crew loss of airplane state awareness, has risen as a causal factor in these accidents. This article explains safety enhancements that were recently adopted by the Commercial Aviation Safety Team and the process that drove the development of the enhancements. Implementation of the resulting training, operations, and airplane design safety enhancements is estimated to reduce the risk of future airplane state awareness events approximately 70 percent by 2018 and 80 percent by 2025.

A LARGE, COMPLEX PROBLEM

Accident rates and fatalities in commercial aviation are at historic lows in recent years, even as air traffic has climbed. However, Boeing continues to work with industry and government partners to improve safety for the traveling public. In August 2015, the Commercial Aviation Safety Team chartered the Airplane State Awareness Joint Safety Analysis Team as a follow-on activity to previous work done by a LOC-I Joint Safety Analysis Team in 2000. The primary purpose of the Airplane State Awareness Joint Safety Analysis Team was to analyze a representative set of LOC-I accidents and incidents in which the flight crew lost awareness of the airplane's state, defined as:

- Attitude (pitch or bank angle), or;
- Energy (the combination of airspeed, altitude, vertical speed, thrust, and configuration control surfaces).

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A review of worldwide transport airplane accidents during the period from 2003 to 2012 revealed that more than half of all LOC-I accidents and resulting fatalities involved flight crew loss of airplane state awareness. The Airplane State Awareness Joint Safety Analysis Team was co-chaired by Boeing and the U.S. Federal Aviation Administration and staffed with subject matter experts from major airplane manufacturers and suppliers, pilot unions, airlines, research organizations, data mining organizations, and government aviation safety departments and agencies. Two analysis teams studied 18 events, identified problems and major themes, and developed intervention strategies. A data team complemented the work of the analysis teams by assessing the presence, frequency, and characteristics of airplane state awareness precursors (conditions commonly leading to these events, such as stall warnings or extreme bank angles) in U.S. Part 121 operations, based on information available in the Aviation Safety Information Analysis and Sharing database.

STUDYING LOSS OF CONTROL– IN-FLIGHT

Nine of the events analyzed involved loss of attitude awareness and nine involved loss of energy awareness. The objective of the analysis was to identify underlying problems that contributed to the accidents and incidents analyzed. In the course of this analysis, the teams identified 161 distinct problems, of which 117 were common with those identified by previous Joint Safety Analysis Teams and 44 were newly developed by the Airplane State Awareness Joint Safety Analysis Team. The analysis teams then identified a total of 274 intervention strategies to address these problems, of which 181 had been documented previously and 93 were newly developed.

COMMON THEMES AMONG LOSS OF CONTROL–IN-FLIGHT

The Airplane State Awareness Joint Safety Analysis Team discovered 12 major themes that appeared across the events in the airplane state awareness dataset, which may be representative of common issues present in similar events. Note that no single factor causes an accident or incident. In these events, it took a combination of at least six themes to result in a hazardous situation. The Airplane State Awareness Joint Safety Analysis Team did not assign a ranking to these themes and notes that higher frequency of occurrence (i.e., appearance in more events) should not necessarily imply greater importance.

- Lack of external visual references. In 17 of the 18 events, the event airplane was flying at night, in instrument meteorological conditions, or in a combination of night and instrument meteorological conditions, sometimes at high altitude or over dark land or water. As a result, the crew had to rely on instrumentation to establish and maintain orientation.
- Flight crew impairment. In seven of the 18 events, at least one member of the flight crew was affected by fatigue, illness, or alcohol consumption, and in some cases by a combination of factors.
- Training. In nine of the 18 events, flight crew training played a role. In some cases, the crew had not received training that is generally considered industry standard and is widely available. In other cases, the training had taken place but was not recalled properly or did not address the scenario encountered. In some instances, the Joint Safety Analysis Team considered the training that the crew had received counterproductive or negative.
- Airplane maintenance. Airplane maintenance was an issue in six of the 18 events. In some cases, maintenance was not performed in a timely manner, allowing problems to persist until they became factors in the accident chain. In other cases, maintenance was performed, but it did not directly address the actual problem or was performed on the wrong system.
- Safety culture. Safety culture played a role in 12 of the 18 events. In some cases, the operator had a poor safety record, extending back for months or years. Many of the flights operated with compromised safety, such as with less than fully functioning systems or with a poorly defined flight plan. In several events, the coordination and interaction with the air traffic management, both in flight planning and during the flight, was poor. Schedule pressure was prevalent, resulting in crews pressing on with flights or other activities despite

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warning signals that the situation was deteriorating. Crew pairing — particularly the pairing of pilots with low time in type — was also an issue (see the section on crew resource management).

- Invalid source data. In five of the 18 events, invalid source data from the air data system sensors or probes, inertial or rate gyro systems, angle-of attack vanes or sensors, or other signals were used as input to primary flight displays, the autoflight system, or the navigation systems with little or no indication the data were invalid.
- Distraction. Distraction played a role in all 18 events and manifested itself in two ways. First, a flight crew would make a decision based on faulty information or incorrect reasoning (sometimes when task-saturated) and would be distracted by pursuit of actions or thought processes associated with that decision, a phenomenon known as confirmation bias. Second, the flight crew would become focused on one instrument or one response to the exclusion of all other relevant inputs, comments, or alerts and would essentially block out any information that may have led them to fully understand the problem they faced, a phenomenon known as channelized attention. Systems knowledge. In seven of the 18 events, the flight crew lacked understanding of how major airplane subsystems — such as autoflight, air data measurement, navigation, and inertial systems — interact and how information from one system influences another.
- Crew resource management. In 16 of the 18 events, crew resource management was not practiced effectively. Specifically, flight crews failed to communicate effectively or work together to understand and resolve problems or confusion. In a number of events, the pilot monitoring failed to properly perform the monitoring function. Crews also failed in some instances to manage their workload properly. In a few events, an authority gradient between the captain and first officer likely played a role in preventing the first officer from taking control of the airplane from the captain, even when the captain was clearly failing to correct a hazardous airplane state.
- Automation confusion/awareness. In 14 of the 18 events, the flight crew was either confused about the state (i.e., on/off) or mode of the autoflight system or else was unaware of trim or control inputs made by the autoflight system.
- Ineffective alerting. In all 18 events, alerting was an issue. The intended function of a flight deck alert is not simply to go off: rather, it is to raise flight crew awareness to a potential hazard, assist the crew in understanding the hazard, and (where possible) provide guidance to avoid or recover from the hazard. The term "ineffective" in this context is meant to convey only that the alert, if present, failed to impact flight crew awareness, understanding, and behavior in the manner intended. It is important to note that alerting effectiveness is not solely the result of airplane design: it is also significantly affected by flight crew training, communication, attention, and other factors in the flight deck environment.
- Inappropriate control inputs. In 12 of the 18 events, the flight crew responded to hazardous airplane states and conditions with control inputs that were opposite to what was necessary to recover the airplane. The term "inappropriate" is intended to convey only that the control inputs were not correct for the purpose of recovering the airplane and should not be construed to automatically imply pilot error.

PREVENTING LOSS OF CONTROL–IN-FLIGHT

Hundreds of intervention strategies were identified by the Airplane State Awareness Joint Safety Analysis Team to mitigate the problems observed in the 18 Airplane State Awareness Joint Safety Analysis Team events, and they were grouped into categories, based on how, and by whom, they would be implemented. These categories include airplane design, flight crew train-

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ing, maintenance, and safety data and research. Airplane design. These interventions called for action on the part of airplane manufacturers or suppliers related to the design of current and future airplanes.

The highest rated interventions related to airplane design fell into these general areas:

- Flight envelope protection.
- Improved alerting.
- Flight path/control guidance on displays.
- Source data integrity.
- "Day-visual meteorological conditions" display systems.
- Automation design.
- Energy management display/prediction systems.

Flight crew training. These interventions called for updates to current flight crew training curricula, standards, additional training, and improvements to flight simulator fidelity. The highest-rated interventions related to flight crew training fell into these general areas:

- Revised approach-to-stall training.
- Expanded upset prevention and recovery training. Scenario-based situations. Stall recognition and recovery. Spatial disorientation recognition and recovery.
- Reemphasized/expanded crew resource management.
- Flight crew proficiency.
- Flight simulator fidelity.

Airline operations and maintenance. These interventions called for action on the part of operators or air traffic management to improve and expand operating policies or procedures. The interventions related to airline operations, including air traffic control issues and airplane maintenance, fell into these general areas:

- Maintenance procedures.
- Flight crew qualifications.
- Nonstandard flight operations.
- Reemphasis and rationale for standard operating procedures.
- Flight crew impairment.
- Safety culture.

Safety data. These interventions called for expanded data mining and sharing programs and safety management principles. The interventions related to safety data fell into these general areas:

- Sharing of safety-related data (e.g., the Aviation Safety Information Analysis and Sharing Program).
- Operator safety management systems.
- Sharing of service difficulty reports.

Research. Research interventions based on the Joint Safety Analysis Team process do not receive an overall effectiveness score. Ranking of research interventions for priority was based on which research interventions addressed the highest number of high-scoring problems. The top research interventions, based on this methodology, fell into these general areas:

- Spatial disorientation. Displays to prevent spatial disorientation. Alerting of spatial disorientation conditions.
- Maintaining flight crew awareness in high-workload environments.
- Automatic systems for error detection, prevention, and recovery.
- Human performance benefits of post stall recovery training using advanced flight simulator aerodynamic models.

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DEVELOPING SAFETY ENHANCEMENTS
After the Airplane State Awareness Joint Safety Awareness Team identified intervention strategies, the Commercial Aviation Safety Team chartered the Airplane State Awareness Joint Safety Implementation Team to review them; assess them for technical, financial, operational, schedule, regulatory, and social feasibility; and develop new safety enhancements. The team then developed detailed implementation plans based on the approved safety enhancement concepts. The proposed training and operations safety enhancements focus primarily on:

- Revisions and improvements to existing flight crew training in upset prevention and recovery, including revised approach-to-stall training.
- Revisions to go-around training.
- Policies and training for prioritizing controlled flight in non-normal situations.
- Training verification and validation.
- Enhancement of crew resource management training to further define and practice the duties of the pilot monitoring.
- Monitoring and understanding of habitual noncompliance to standard operating procedures and improvements to standard operating procedures.
- Policies for conducting nonstandard, nonrevenue flights.

In addition to training and operations safety enhancements, the team generated three airplane design safety enhancements that the Commercial Aviation Safety Team has adopted and that Boeing and other Commercial Aviation Safety Team–represented airplane manufacturers have committed to implementing on their next all-new type designs:

- Flight envelope protection. This safety enhancement has already been implemented by Boeing on its latest fly-by-wire commercial airplanes, the 777 and the 787.
- Bank angle alerting with recovery guidance. Boeing is now working to implement this safety enhancement in the 737 MAX and the Next-Generation 737.
- Virtual day-visual meteorological conditions displays. Boeing's commitment is contingent on successful completion of relevant research and development and supporting industry standards. Boeing recently demonstrated these displays, also referred to as synthetic vision systems, in the 787 EcoDemonstrator. Because these displays are effective at supporting flight crew attitude awareness, Boeing continues to engage with government and industry partners in research and development to bring these systems to application readiness.

The airplane state awareness safety enhancements are integrated into a coordinated safety plan with a goal of balancing short-term tactical mitigations provided by operational and training programs with longer term, more strategic solutions resulting from improved design. The airplane state awareness safety enhancement portfolio was constructed by the Airplane State Awareness Joint Safety Implementation Team to provide both near and far-term solutions that reinforce each other and provide a balanced, redundant approach to addressing the issue of flight crew loss of airplane state awareness. Like the underlying problem being solved, the solution set is complex and addresses multiple issues. The analysis estimates that implementation of the training, operations, and airplane design safety enhancements would reduce the risk of future airplane state awareness events approximately 70 percent by 2018 and 80 percent by 2025. The Airplane State Awareness Joint Safety Implementation Team recommended adoption by all U.S. Commercial Aviation Safety Team members of the training, operations, and design safety enhancements, and it recommends these enhancements be communicated to international aviation safety communities for their review and implementation where applicable. The Commercial Aviation Safety Team and its members have now officially adopted and published these safety enhancements as part of the Commercial Aviation Safety Team Safety Enhancement Plan and are working with the International Civil Aviation

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Organization and the international safety community to increase adoption worldwide. The plan can be found at: http://www.skybrary.aero/index.php/Portal:CAST_SE_Plan.

SUMMARY

Loss of airplane state awareness plays a significant role in at least half of all LOC-I category events. An industry analysis of a representative set of events identified specific problems and major themes and resulted in proposed interventions that cover a broad spectrum of potential solutions in the areas of airplane design, flight crew training, airline operations and maintenance, and safety data. The Commercial Aviation Safety Team has now officially adopted the resulting safety enhancements and is working to implement them in the United States and worldwide.

## GUARD YOUR POSESSIONS

*[Ed: There has been a marked increase in cases of carry-on baggage being ransacked and high value items taken. This is occurring primarily on long haul international flights, where it is common for a passenger to be sleeping. Take note of the report below, published in ATW Daily News.]*

**VHHH/Hong Kong** According to reports on 13JAN, thieves targeted a South African national aboard South African Airways flight 286 from Johannesburg to Hong Kong on 21 December. The victim stated that a fellow passenger alerted him that other passengers had taken his baggage while he was sleeping and rummaged through it in the aircraft lavatory. When the victim subsequently inspected his baggage, he found that the lock had been broken and foreign currency worth approximately $1200, as well as items of jewelry, were missing. Hong Kong police officers searched several suspects when the aircraft landed, but the stolen items were not found. This type of crime is reportedly a significant problem on international flights bound for Asian destinations, particularly Hong Kong. According to statistics released by Hong Kong authorities in August 2020, a total of 45 in-flight robberies had been reported up to that point in 2019; 48 cases occurred in 2018. Cash, jewelry and smartphones are especially targeted.

**The Kalitta Charters Safety Chronicle is published every quarter by the Safety Department. Please feel free to contact us with questions, comments and suggestions at:**

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