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D I G E S T

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Line Operations Safety Audit (LOSA) Provides Data On Threats and Errors

Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 900 member organizations in more than 150 countries.

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Line Operations Safety Audit (LOSA) Provides Data on Threats and Errors

Structured observations of routine flight operations help reveal an airline's strengths and weaknesses. The nonpunitive data-collection program — a planned cornerstone of internationally required safety management systems — is being adapted to other areas, including flight dispatch, apron operations and air traffic control.

—FSF EDITORIAL STAFF

The line operations safety audit (LOSA) — which involves the collection of data by trained observers during routine flights to determine how flight crews detect, manage and mismanage threats and errors — has been endorsed by the International Civil Aviation Organization (ICAO) as a tool for monitoring normal flight operations and developing countermeasures against human error.[1]

ICAO in 2002 published Document 9803, *Line Operations Safety Audit (LOSA)*, which contains detailed information on planning and conducting a LOSA. The manual provides guidelines for airlines on using LOSA data to gauge operational strengths and weaknesses. LOSA also enables airlines to compare data among de-identified data gathered by other airlines.

"Document 9803 is the bible of LOSA," said Capt. Don Gunther, director of human factors and safety for Continental Airlines.[2] "The beauty of following the guidelines in '9803' is that you can compare your data with all other airlines that have done LOSAs. You don't know who the other airlines are, but the de-identified data indicate how you compare to the industry.

"If you have an issue, and no one else does, you can find out what you're doing wrong. If you have

> "LOSA provides airlines with earlier warnings of potential problems."

an issue, and everybody else does, too, you know it's an industry issue; and collectively, we might be able to find a solution."

LOSA complements other safety-data-collection systems such as flight-data monitoring (e.g., flight operational quality assurance [FOQA] programs) and voluntary reporting (e.g., aviation safety action programs [ASAP]).

Capt. Daniel E. Maurino, coordinator of the ICAO Flight Safety and Human Factors Program, said that the organization currently is drafting standards for safety-management systems that will include LOSA, FOQA and ASAP as essential components.[3]

"LOSA has raised the level of safety analysis and provides airlines with earlier warnings of potential problems," he said. "With FOQA, for example, we know that we have a problem with unstabilized approaches, but we need to experience the unstabilized approaches to trigger the data capture. It's the same thing with ASAP."

LOSA conferences are conducted annually by ICAO. The first conference was in Hong Kong, China, in 2000. Subsequent conferences were conducted in Panama City, Panama; Dubai, United Arab Emirates; Dublin, Ireland; and Seattle, Washington, U.S. The next conference will be conducted Sept. 27–28, 2005, in Kuala Lumpur, Malaysia.

Program Initiated to Check CRM

With funding from the U.S. Federal Aviation Administration (FAA), the University of Texas at Austin (Texas, U.S.) Human Factors Research Project (UTHF) in the early 1990s placed trained observers in aircraft jump seats to help airlines gauge the effectiveness of crew resource management (CRM) during routine airline flights.

The flight observations were the precursors of LOSA. Robert L. Helmreich, Ph.D., a professor of psychology at the University of Texas and leader of the UTHF, said that the first flight observations were conducted in 1994 at the request of Delta Air Lines.[4]

"This study involved the observation of 480 line flights," Helmreich said. "Delta Air Lines had developed and implemented an intensive multi-day CRM training course, which it believed had improved crew coordination and enhanced safety. However, senior airline management felt it important to confirm whether the behaviors being taught were, in fact, practiced during line operations."

Similar flight observations were conducted by Air New Zealand, American Airlines, Continental Airlines, Trans World Airlines and US Airways. The observations showed that the practice of CRM on the flight deck was substantially different than in airline training environments and resulted in the development of advanced CRM concepts and "new ways of thinking about crew performance," ICAO said.

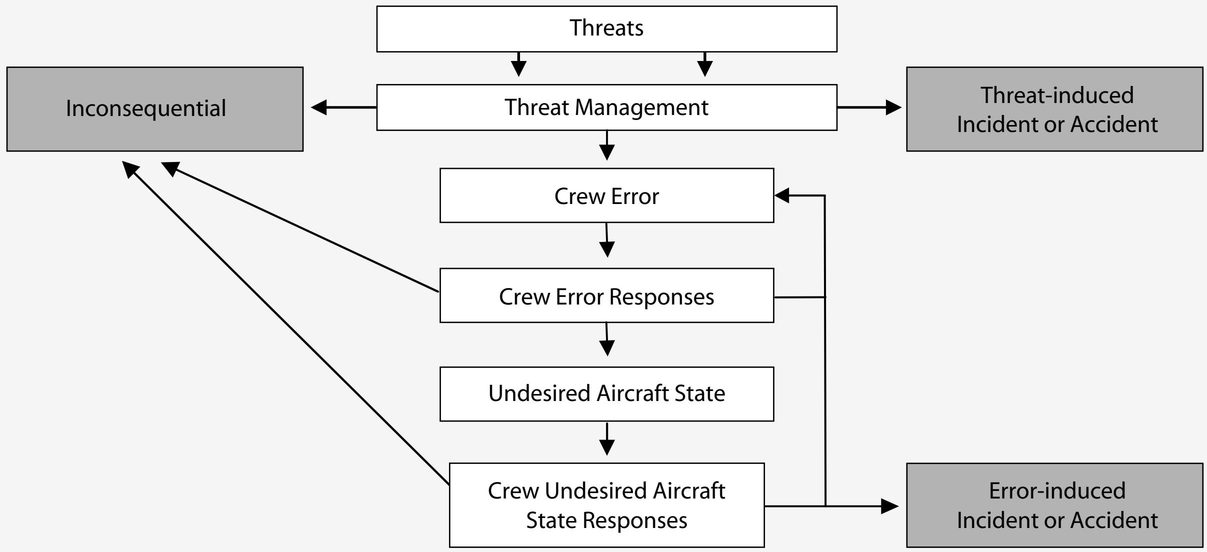
Helmreich said that the early flight observations did not provide adequate information about how flight crews adhere to standard operating procedures (SOPs) or about environmental influences on crew performance. UTHF and Continental Airlines in the late 1990s expanded the concept and methodology to include the recording of threats (e.g., adverse weather conditions) and errors (e.g., human mistakes) and how flight crews deal with them.

"This change greatly enhanced the usefulness of LOSA for airlines, expanding it from a CRM audit to one which places CRM skills into perspective as operational threat-and-error countermeasures," he said.

TEM Model Provides Focus

The concept and methodology of LOSA currently are based on the threat-and-error management (TEM) model developed by UTHF (Figure 1, page 3). ICAO calls TEM the "fifth generation of CRM," which, in the context of LOSA, is based on the premise that "human error is ubiquitous, inevitable and a valuable source of information."[5]

Figure 1
Threat-and-error Management Model



Source: Adapted from James R. Klinect, University of Texas at Austin (Texas, U.S.) Human Factors Research Project

"Essentially, the model posits that threats and errors are integral parts of daily flight operations and must be managed," ICAO said.[6] "Therefore, observing the management or mismanagement of threats and errors can build the desired systemic snapshot of performance."

ICAO said that the TEM model provides a framework for data collection and categorization, and helps to answer questions such as the following:

- "What type of threats do flight crews most frequently encounter? When and where do they occur, and what types are most difficult to manage?
- "What are the most frequently committed crew errors, and which ones are the most difficult to manage?
- "What outcomes are associated with mismanaged errors? How many result in an undesired aircraft state [e.g., altitude deviation, marginal fuel supply, unstable approach]? [and,]
- "Are there significant differences between airports, fleets, routes or phases of flight vis-à-vis threats and errors?"

Threats are defined as expected or unexpected external situations that must be managed by the flight crew.

"[Threats] increase the operational complexity of the flight and pose a safety risk to the flight at some level," ICAO said.

Threats Include Errors by Others

Threats include adverse weather conditions, hazardous terrain, aircraft and aircraft system abnormalities and malfunctions, time pressures and unfamiliar airports. Threats also include errors that are committed by others — including ground-handling personnel, maintenance technicians, dispatchers, flight attendants and air traffic controllers — and that must be managed by the flight crew.

Flight crew errors are defined as actions and inactions that lead to deviations from the intentions or expectations of the flight crew or the airline.

"Errors, in the operational context, tend to reduce the margin of safety and increase the

Most errors that occur during routine flight operations have inconsequential outcomes.

probability of accidents or incidents," ICAO said.

The TEM model characterizes flight crew errors as follows:

- *Intentional noncompliance errors* are "willful deviations from regulations and/or operator procedures," ICAO said. Examples include violating the "sterile-cockpit rule,"[7] omitting required callouts, using nonstandard pilot-controller communication phraseology, conducting checklists from memory, and failing to respond to traffic alert and collision-avoidance system (TCAS) warnings or terrain awareness and warning system (TAWS) warnings;[8]

- *Procedural errors* are "deviations in the execution of regulations and/or operator procedures [in which] the intention is correct but the execution is flawed." This category includes errors in which flight crewmembers forget to do something. Examples include failing to conduct checklists, incorrectly setting instruments and failing to cross-check instrument settings;

- *Communication errors* include "miscommunication, misinterpretation or failure to communicate pertinent information among the flight crew or between the flight crew and an external agent [e.g., air traffic controller, ground-handling personnel]." Examples include failing to hear air traffic control (ATC) instructions, failing to read back ATC instructions and crew miscommunication;

- *Proficiency-based errors* involve "lack of knowledge or psychomotor ('stick-and-rudder') skills." Examples include inadequate knowledge of aircraft systems and equipment that contribute to hand-flying errors, automation errors or other errors that can influence the direction, speed or configuration of the aircraft; and,

- *Operational decision errors* are "decision-making errors that are not standardized by regulations or operator procedures and that unnecessarily compromise safety." ICAO said that an operational decision error includes at least one of the following conditions: the flight crew ignores a more conservative option; the crewmember who took the decision does not brief other crewmembers about the decision; or the crew does not use available time to evaluate options. Examples include navigating through known areas of adverse weather and accepting ATC instructions that result in an unstable approach.

The TEM model posits that when an error occurs, the flight crew either *traps* (i.e., detects and manages) the error, *exacerbates* the error with action or inaction that results in additional error, or *fails to respond* to (i.e., ignores) the error.

Crews Trap Most Errors

Most errors that occur during routine flight operations are trapped and thus have inconsequential outcomes, ICAO said. When a crew exacerbates an error or fails to respond to an error, the outcome could be an undesired aircraft state, an accident or an incident.

Maurino said that the concept of undesired aircraft state is a hallmark of LOSA.

"An undesired aircraft state is a transitional state, and the crew is still in the 'driver's seat,' so to speak," he said. "An airspeed deviation, for example, might be corrected by the crew before the approach becomes unstabilized. The observer can capture what the crew is doing — successful strategies to prevent an unstabilized approach. And that is a success story."

Following are examples of incidents observed during flight observations and how they fit in the TEM model:[9]

- Before departure, the first officer committed a procedural error when he entered an incorrect waypoint in the flight management system (FMS). The error was inconsequential because it was trapped during a subsequent cross-check of FMS data;

- A communication error was committed when the pilot not flying told the pilot flying to taxi onto the wrong runway. The pilot flying exacerbated the error by taxiing onto the wrong runway. The outcome was inconsequential because the undesired aircraft state (being on the wrong runway) was managed by a review of the airport chart and by taxiing the aircraft off the wrong runway; and,

- Nearing Flight Level (FL) 220 (approximately 22,000 feet) during climb, the controller told the crew to maintain FL 220; the captain committed a procedural error when he inadvertently pushed the autopilot altitude-hold button twice, thus engaging and disengaging the altitude-hold mode. The crew did not notice the error, but the captain observed the undesired aircraft state (altitude deviation) and recovered by flying the aircraft to the assigned altitude and properly engaging the altitude-hold mode.

Continental Did First TEM LOSA

Continental Airlines in 2000 conducted the first systemwide LOSA based on the TEM model. The airline conducted the second systemwide LOSA in 2004. Gunther said that LOSAs will be conducted about every four years.

"It's a cycle," he said. "We do the LOSA, we make the changes, and we work with the check airmen to make sure that they understand why those changes were made, so that they can pass that information on to the pilots. All that occurs over a two-year to three-year period; then, we prepare for the next LOSA."

Continental also has conducted what it calls "spot LOSAs," focusing on specific fleets or regions. In 1998, for example, the airline conducted a spot LOSA of its South American operations.

"We wanted to see how our policy and procedures were fitting into what we consider a high-threat environment," Gunther said. "Some of the airports have mountainous terrain and various approaches, and there are other differences from our domestic operations. We collected some good data and made a few changes based on that data."

Gunther said that observer training and observer "calibration" are critical to the success of a LOSA. "For any observer, there is a learning curve," he said. "Our initial observer training is a two-day course. Then, after conducting a couple of flight observations, the observers and the trainers go over the observations and recalibrate the observers, to make sure they are on track."

Most flight observations are conducted by Continental line pilots. Gunther said that about 15 percent are conducted by non-pilots.

"There's very little difference in the observations as far as content and grading," he said.

Capt. Bruce Tesmer, manager of LOSA and ASAP for Continental, said that non-pilot observers have included former FAA flight standards district office managers, a former vice chairman of the U.S. National Transportation Safety Board and human factors specialists trained in the airline's operations.[10]

"We put them in the simulator, and until they [the observers] can land the airplane, they cannot conduct an audit," Tesmer said.

Gunther said that Continental pilots have become increasingly enthusiastic about LOSA. At first, pilots agreed to be observed because of the 'no-jeopardy' [i.e., anonymous and nonpunitive] provisions of the program. In subsequent LOSAs, most pilots openly welcomed the observers.

"The majority of our pilots are very pleased with the observations, and the reason is because they have seen positive safety changes that have come out of it," he said.

Continental's LOSAs include a brief safety survey and crew interview. The survey focuses on the company's safety culture. A typical question is: "What are your feelings about safety issues and how they are addressed?" The interview questions cover specific issues.

"There are only about four or five questions, and they are targeted," Gunther said. "We go to our flight standards, training, flight operations and safety departments, and determine what we need to know.

"For any observer, there is a learning curve."

For example, we might want to know how a checklist change has affected their productivity. There's an open question at the end, asking if they have anything to add. Pilots always have something to add."

Observations Reveal 'Best Practices'

What has Continental Airlines gained from LOSA?

"Because of the information from LOSA and the adjustments in our training, including implementing a threat-and-error management program, we have seen tremendous improvements in the use and standardization of our checklists, in the way our crews fly their approaches and in overall crew performance," Gunther said. "One of the things you learn is what 'good' crews do — what are the best practices out there — and you can pass that information along."

Continental found that crews who verbalize their actions make fewer automation errors.

"For example, ATC says that the altimeter setting now is 29.32; one pilot enters 29.32 in his altimeter, the other pilot enters 30.32 in his altimeter and levels off 1,000 feet from the assigned altitude," Gunther said. "What if the first pilot had verbalized, 'The altimeter is twenty-nine thirty-two.' With that little bit of verbalization, the other pilot might have caught the mistake."

Tesmer gave another example that involved a first officer's personal strategy for stowing paperwork.

"There's very limited space in the cockpit for paperwork," Tesmer said. "I have seen paperwork strewn all over the console and wedged between the fire handles and behind the fire-extinguisher bottle on the circuit breaker panel. None of those is a good option."

The first officer used a small clipboard, with an attachment that allows it to be stowed near his right leg when not in use, to organize paperwork.

"Every time he needs a document, it's right at his fingertips," Tesmer said. "Those little things — those personal strategies that work — when you pass them around, people say, 'That's a good idea. I think I'll try that.'"

How does the airline pass the information around?

"The most effective document that we give our crews is the newsletter," Tesmer said. "You can give crews a research report, and most of them won't get past page two. Give them a newsletter that's brief and has good information, and they will read it."

ATC Threats Are Most Frequent

As of October 2004, 21 airlines worldwide had conducted LOSAs or were conducting their first LOSA. Three airlines had conducted multiple LOSAs.[11]

UTHF presented data from 1,310 U.S. airline flight observations at an FAA conference in October 2004; the data showed the following:

- One or more threats occurred during 90 percent of the flights;
- Crew error resulting from mismanaged threats occurred during 22 percent of the flights;
- The most frequent threats were from ATC (encountered during 47 percent of the flights); weather conditions (40 percent of the flights) and aircraft malfunctions or minimum-equipment-list items (23 percent of the flights);
- Among the ATC threats, 50 percent involved the issuance of difficult/demanding clearances and 20 percent involved a runway change; 14 percent of these threats were mismanaged; and,
- Of the mismanaged ATC threats, 66 percent occurred during descent, approach and landing.

The data showed the following results about errors:

- One or more errors occurred during 64 percent of the flights;
- The most frequent errors involved hand-flying (21 percent); checklists (20 percent) and communication/coordination between flight crews and ATC; and,
- Most of the errors (43 percent) occurred during descent, approach and landing; 27 percent occurred before departure; 22 percent occurred on takeoff; and 4 percent occurred during cruise.

Multiple Audits Identify Trends

Data collected by a U.S. airline during its first systemwide LOSA showed an undesired number of below-standard leadership ratings of captains, a high number of approaches that did not meet the airline's criteria for stabilized approaches and a low rate of error trapping.[12]

Among actions taken by the airline were the implementation of a leadership module in its recurrent training syllabus, revision of stabilized-approach procedures and implementation of error-management training for pilots and check airmen.

When the second LOSA was conducted three years later, the airline found a significant improvement in leadership ratings, a 70 percent reduction in unstabilized approaches continued below

1,000 feet and a twofold increase in the error-trapping rate.

Specific Operating Characteristics Defined

Although airlines are encouraged to set their own goals and to determine how a LOSA can be conducted most effectively to meet their needs, ICAO has established the following specific *operating characteristics* that must be incorporated in a LOSA:

- *Jump-seat observations during normal line operations.* Observations must be conducted during routine flights, rather than during line checks or training flights when the presence of another observer would increase "an already high stress level, thus providing an unrealistic picture of [flight crew] performance";

- *Joint management/pilot sponsorship.* Among the first steps in conducting a LOSA is to achieve a signed agreement between airline management and pilots (typically, the pilot organization) and to form a steering committee comprising representatives of both parties. The function of the steering committee is to oversee the planning and scheduling of flight observations, and the verification of data collected during the observations;

- *Voluntary crew participation.* A flight observation cannot be conducted without the flight crew's permission. "The crew has the option to decline, with no questions asked," ICAO said. "The observer simply approaches another flight crew on another flight and asks for their permission to be observed";

- *De-identified, confidential and safety-minded data collection.* Observers must not record anything that could identify flight crews or flights — including names, flight numbers and dates. "This allows for a level of protection against disciplinary actions," ICAO said. "The purpose of LOSA is to collect safety data, not to punish pilots. … If a LOSA observation is ever used for disciplinary reasons, the acceptance of LOSA within the airline will most probably be lost forever";

- *Targeted observation instrument.* Most airlines use the LOSA observation form developed by UTHF (see Appendix A, page 12) to record general flight information (e.g., city pairs, aircraft type, crew experience), crew performance in detecting and managing threats and errors during various phases of the flight, and other information. "It is not critical that an airline use this form, but whatever data-collection instrument is used needs to target issues that affect flight crew performance in normal operations," ICAO said;

- *Trusted, trained and calibrated observers.* Observers typically are selected from among the airline's line pilots, instructor pilots, safety pilots and management pilots, and from the pilot organization's safety committee members. "It is critical to select observers [who] are respected and trusted within the airline to ensure the line's acceptance of LOSA," ICAO said. Before conducting flight observations, the observers must receive training on LOSA concepts and methodology, including the use of the targeted observation instrument;

- *Data-verification round tables.* "A round table consists of three or four department [representatives] and pilots' association representatives who scan the raw data for inaccuracies," ICAO said. "The end product is a database that is validated for consistency and accuracy according to the airline's standards and manuals, before any statistical analysis is performed";

- *Data-derived targets for enhancement.* "As the data are collected and analyzed, patterns emerge," ICAO said. "Certain errors occur more frequently than others, certain airports or events emerge as more problematic than others, certain SOPs are routinely ignored or modified, and certain maneuvers pose greater difficulty in adherence than others. These patterns are identified for the airline as LOSA targets for enhancement. It is then up to the airline to develop an action plan based on these targets"; and,

- *Feedback of results to the line pilots.* "Pilots will want to see not only the results but also management's plan for improvement," ICAO said.

LOSA Collaborative Provides Assistance

Most airlines that have conducted LOSAs since 2001 have engaged the services of a private organization, the LOSA Collaborative, in the program.

James R. Klinect, CEO and managing director of the LOSA Collaborative and a part-time UTHF researcher, said that he formed the organization after FAA reduced funding for LOSA.[13]

"FAA was interested in funding work done with U.S. airlines," he said. "Over time, we noticed that the funding was constantly being cut. Because of the funding shortfalls and because we had done cross-cultural work before and wanted to branch out from the U.S. airlines, we formed the LOSA Collaborative. Instead of having airline LOSAs funded by research dollars, we have passed the costs along to the airlines."

Among the organization's services are participation in program planning and observer training. Independent observers trained by the LOSA Collaborative are available to participate in flight observations.[14]

"We have a cadre of about 12 observers based around the world (Australia, England, New Zealand, Singapore and the United States)," Klinect said. "All of our observers are retired pilots. Many of them are former check airmen, and some were training-program developers. We ask the airline for copies of their manuals several weeks before a project, so we can have some familiarity with their operation.

"Since the start of the LOSA Collaborative in 2001, the only non-pilot from our group conducting observations has been me. I try to conduct one or two observations during every project to keep current."

Nevertheless, airlines sometimes use non-pilot employees as observers.

"Non-pilots are not used unless they have enough familiarization with company SOPs and are able to anticipate flight crew actions in a cockpit," Klinect said. "Therefore, non-pilot ground school or simulator instructors are great examples and have been used as LOSA observers representing the airline. This is rare, though; most LOSA observers representing their airline are current line pilots."

The LOSA Collaborative provides a computer program that facilitates the recording of notes and data gathered by observers.

"The files are sent to the LOSA Collaborative, and we build a database," Klinect said. "We conduct round tables with airline personnel to verify the data — ensuring, for example, that the observed errors are actually errors according to the airline's flight standards. We then analyze the data and provide a full report of our findings to the airline."

The final report identifies targets for enhancement and de-identified, aggregate data from other airlines, where appropriate.

Only UTHF researchers have access to de-identified data that airlines have agreed to submit for research.

"When we provide the final report, we include a comparison with other airlines on data such as threat-management rates, automation errors and so forth," Klinect said. "We might say, for example, that 40 percent of the customer-airline's observed flights had an aircraft-malfunction threat that the crew had to manage, compared to 10 percent to 15 percent of the observed flights at other airlines. We'll tell the customer airline that this is a target for enhancement, that they might want to look at this because their rate is so much higher than other airlines."

Fees for the organization's services vary according to the scope of the LOSA. Klinect said that fees typically range from about US$50,000 for a relatively small airline to about $100,000 for a large airline.

"Seventy-five percent of that fee is for data verification and analysis, and for preparing the final report," he said.

Klinect said that he knows of only two airlines that have conducted LOSAs adhering to all 10 operating characteristics specified by ICAO without the assistance of the LOSA Collaborative: Futura International Airways and Lan Chile.

"I don't know of any major carriers that have done it by themselves," he said. "Airlines that conduct their own LOSAs do not send their data to the LOSA Collaborative; their data likely would not match our database."

Klinect said that only UTHF researchers have access to de-identified data that airlines have agreed to submit for research. Otherwise, all data are kept in confidence within the LOSA Collaborative.

Steering Team Guides Program

The LOSA steering team should be led by the airline's safety department, which typically conducts internal audits, confidential incident-reporting systems and flight-data-monitoring programs, and "often holds the trust of the line pilots regarding confidential information," ICAO said.[15]

The steering team decides which flight operations will be observed and selects specific targets for the observations.

"One common mistake is to try to tackle too much at one time," ICAO said. "When doing this, the effort can be enormous and the data findings can be overwhelming."

Focusing a LOSA on a specific fleet or flight operation can help keep the program manageable. For example, one airline decided to conduct its first LOSA on international operations and to focus on domestic operations in a later LOSA.

ICAO said that although observations of every flight crew would be ideal, this is not necessary to collect sufficient data. Depending on the size of the fleet or flight operation, observation of 30 flight crews to 50 flight crews is sufficient to provide statistically valid data.

Findings from confidential-reporting programs and from FOQA can help in the selection of specific targets, such as checklist usage and approach stabilization.

Good Observers Are 'Flies on the Wall'

Observers should be selected carefully because "the quality of data collected depends entirely on who is collecting that data," ICAO said. An important requirement is knowledge of the airline's procedures and operations. Check airmen and instructors, however, must step out of these roles when conducting LOSA observations.

"Observers should create an environment where the crews hardly realize that they are being observed," ICAO said. "It is imperative that crews do not feel as if they are being given a check ride. … The LOSA observers must clearly understand that their role is limited to collecting data, not to disciplining or critiquing flight crews."

Experience has shown that the best data-collection results have been achieved by observers who used a "fly-on-the-wall" approach.

"The best observers learn to be unobtrusive and nonthreatening; they use a pocket notebook while in the cockpit, recording minimal detail to elaborate on later," ICAO said. "At the same time, they know when it is appropriate to speak up if they have a concern, without sounding authoritarian."

Results Should Be Shared With Pilots

After analysis of the data is completed, a written report should be prepared for airline managers and pilots. The report should present the overall findings clearly and concisely.

"It is imperative that crews do not feel as if they are being given a check ride."

Capt. Alex de Silva, division vice president of safety, security and environment for Singapore Airlines, which conducted a LOSA in 2003 and will conduct another audit in 2006, said that the recommendations included in the final report are a crucial element.[16]

"The LOSA steering committee should address all the issues identified in the report," he said. "Subject-matter experts from each area should formulate a two-pronged action plan that combines specific approaches and systemic approaches to resolve the areas identified as targets for enhancement."

ICAO said, "The LOSA report should clearly describe the problems the analyzed data suggest but should not provide solutions. These will be better provided through the expertise of each of the areas in question [e.g., operations, training, standards]."

ICAO recommends the following report outline:

- "Introduction — Define LOSA and the reasons why it was conducted;
- "Executive summary — Include a test summary of the major LOSA findings (no longer than two pages);
- "Section summaries — Present the key findings from each section of the report, including:
  - "Demographics;
  - "Safety interview results;
  - "External threats and threat-management results;

– "Flight crew errors and error-management results;

– "Threat-and-error countermeasure results; [and,]

- "Appendix — Include a listing of every external threat and flight crew error observed, with the proper coding and an observer narrative of how each one was managed or mishandled."

ICAO said that the airline must then take action on the identified targets for enhancement, or the LOSA data "will join the vast amounts of untapped data already existing throughout the international civil aviation community."

Data Must Be Protected

Specialists agree that LOSA — like other aviation-safety-data-collection tools — will not be effective if the data cannot be protected from unwarranted use in judicial proceedings and disciplinary actions.

LOSA has the support of the International Federation of Air Line Pilots' Associations (IFALPA) because of the protections included in its definition.

"It is interesting to note that six out of the 10 operating characteristics of LOSA specifically protect pilots who take part in a LOSA audit," said James Eales, technical officer for the IFALPA Human Performance Committee.[17] "An audit will be successful only if the safeguards incorporated are enforced; without them, the audit will have a negative effect on safety."

The airline must take action on the identified targets for enhancement.

Eales said that IFALPA has drafted a policy on auditing systems for consideration at the organization's annual conference in April 2005.

"The [draft] policy clearly states the requirements necessary for an audit to be acceptable to IFALPA and highlights the safeguards that we think are necessary," he said. "The main requirement is that the audit should be a tool for enhancing safety and not used for disciplinary purposes or personnel checking. LOSA meets our requirements."

Capt. Carlos Arroyo-Landero, chairman of the IFALPA Human Performance Committee, said that a recent resolution adopted by the ICAO Assembly is "the necessary first step" to ensuring the protection of aviation safety data.[18]

The resolution, adopted by the ICAO Assembly in September 2004, instructs the ICAO Council to develop legal guidance to assist member states to "enact national laws and regulations to effectively protect information from safety-data-collection systems, both mandatory and voluntary, while allowing for the proper administration of justice in the state."

Concept Expands to Other Operations

The LOSA concept currently is being applied to other operations. Continental Airlines has applied the concept to monitor dispatch operations and apron (ramp) operations. ICAO is adapting the concept to monitor ATC operations.

In late January 2005, Continental had completed the first phase of its dispatch LOSA, which involved observations of routine dispatch operations by three dispatchers trained in the LOSA concept and methodology. The airline also had completed the training of ground-handling personnel to conduct the observations of routine ramp operations.

"The preliminary data from the first phase of the dispatch LOSA looks really promising," Gunther said. "Again, we're going to do the data collection in three parts: the observations, the survey and the interview.

"The ramp is very different than flight operations, which has two people in a very confined environment. On the ramp, there are several people in a much more open environment. We have studied the ramp, and we know what areas we're going to target."

Maurino said, "We have received a mandate from our customers — our states — to explore the extension of the concept of monitoring routine operations to ATC, using as a basis the LOSA methodology adapted to the ATC environment."

ICAO has formed the Normal Operations Safety Survey (NOSS) Study Group to advance the concept.

"Instead of calling it LOSA in ATC, we're calling it NOSS," Maurino said. "The NOSS Study Group has had one meeting, and we have made an analysis of the LOSA methodology. We identified aspects that can transfer directly to ATC and other aspects that need considerable rework. All in all, the conclusion of this first meeting is that we can develop a methodology to observe normal ATC operations based on the LOSA methodology."

Development of NOSS methodology, including an observation form and observer-training procedures, currently is underway. The group plans to hold a conference in Europe near the end of 2005 to brief the community on its progress.

Maurino said that the LOSA concept likely will be extended into other operations.

"There is no question that the methodology is valid across the board for different activities in aviation," he said. "There is no reason why the methodology could not be applied in maintenance, for example. It should be, and it's quite possible. The crux of the question is the level of trust between the work force and the organization. If there is no trust, it is impossible to have an external observer looking over your shoulder. You have to be comfortable."■

Notes

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7. The *sterile cockpit rule* refers to U.S. Federal Aviation Regulations (FARs) Part 121.542, "Flight Crewmember Duties," which states: "No flight crewmember may engage in, nor may any pilot-in-command permit, any activity during a critical phase of flight which could distract any flight crewmember from the performance of his or her duties or which could interfere in any way with the proper conduct of those duties. Activities such as eating meals, engaging in nonessential conversations within the cockpit and nonessential communications between the cabin and cockpit crews, and reading publications not related to the proper conduct of the flight are not required for the safe operation of the aircraft. For the purposes of this section, critical phases of flight include all ground operations involving taxi, takeoff and landing, and all other flight operations conducted below 10,000 feet, except cruise flight."

   European Joint Aviation Requirements JAR–OPS 1.085, "Crew Responsibilities," states that the commander (pilot-in-command) "shall … not permit any crewmember to perform any activity during takeoff, initial climb, final approach and landing except those duties required for the safe operation of the aeroplane."
8. *Terrain awareness and warning system* (TAWS) is the term used by the European Joint Aviation Authorities and the U.S. Federal Aviation Administration (FAA) to describe equipment meeting ICAO standards and recommendations for ground-proximity warning system (GPWS) equipment that provides predictive terrain-hazard warnings; *enhanced GPWS* and *ground collision avoidance system* are other terms used to describe TAWS equipment.
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Appendix

University of Texas Line Operations Safety Audit (LOSA) Observation Form With Sample Observations

Observer Information

Observer ID (Employee number)	*3059*	**Observation Number**	*#1*

Crew Observation Number (e.g., "1 of 2" indicates segment one for a crew that you observed across two segments)	*1*	**of**	*1*

Flight Demographics

City Pairs (e.g., PIT-CLT)	*PIT – LAX*		
A/C Type (e.g., 737-300)	*B-757*		
Pilot flying (Check one)	**CA**	**FO**	*X*

Time from Pushback to Gate Arrival (Hours:Minutes)	*4:55*	**Local Arrival Time** (Use 24 hour time)	*09:55*
Late Departure? (Yes or No)	*Yes*		

Predeparture/Taxi

Narrative	Your narrative should provide a context. What did the crew do well? What did the crew do poorly? How did the crew manage threats, crew errors, and significant events? Also, be sure to justify your behavioral ratings.

The CA established a great team climate — positive with open communication. However, he seemed to be in a rush and not very detail oriented. The FO, who was relatively new to the A/C, tried to keep up but fell behind at times. The CA did not help the cause by interrupting the FO with casual conversation (marginal workload management).

All checklists were rushed and poorly executed. The CA was also lax verifying paperwork. This sub-par behavior contributed to an undetected error — the FO failed to set his airspeed bugs for T/O (poor monitor/cross-check). The Before Takeoff Checklist should have caught the error, but the crew unintentionally skipped over that item. The FO noticed the error upon commencing the takeoff roll and said, "Missed that one."

The Captain's brief was interactive but not very thorough (marginal SOP briefing). He failed to note the closure of the final 2000' of their departing runway (28R) due to construction. Taxiways B7 and B8 at the end of the runway were also out. The crew was marked "poor" in contingency management because there were no plans in place on how to deal with this threat in the case of a rejected takeoff.

[A/C = Aircraft CA = Captain FO = First officer SOP = Standard operating procedure T/O = Takeoff]

Appendix

University of Texas Line Operations Safety Audit (LOSA) Observation Form With Sample Observations *(continued)*

Takeoff/Climb

Narrative	Your narrative should provide a context. What did the crew do well? What did the crew do poorly? How did the crew manage threats, crew errors, and significant events? Also, be sure to justify your behavioral ratings.

Takeoff was normal. ATC granted a right turn VFR climb which was commenced at 600 ft. Climb to flight level 20000 with step climbs to 35000 ft. Eventually leveled at 31000 ft about 90 miles North. When established at FL200, ATC cleared the crew to FL270. They accepted and the First Officer dialed 230 instead of 270 in the MCP. The Captain caught the error on cross-verification.

[ATC = Air traffic control   FL = Flight level   ft. = Feet   MCP = Mode control panel   VFR = Visual flight rules]

Cruise

Narrative	Your narrative should provide a context. What did the crew do well? What did the crew do poorly? How did the crew perform during the handover?

Crew stayed attentive to aircraft position throughout cruise.

Appendix

University of Texas Line Operations Safety Audit (LOSA) Observation Form With Sample Observations *(continued)*

Descent/Approach/Land/Taxi

Narrative	Your narrative should provide a context. What did the crew do well? What did the crew do poorly? How did the crew perform during the handover?

Briefing to TOD — The approach brief much better than their takeoff brief. They expected runway 25L from the Civet Arrival for a straight-in visual approach. Jepp charts were out, contingencies talked about, and everything was by the book (outstanding SOP brief and plans stated).

10000' to slowing and configuring — ATC cleared the crew to 25L, but at 8000', ATC changed us to the Mitts Arrival for runway 24R due to a slow moving A/C on 25L. The CA changed the arrival and approach in the FMC, tuned the radio, and quickly briefed 24R. As soon as everything was clean, ATC called back and told the crew they could either land on 25L or 24R at their discretion. Since time was a factor, the crew discussed and decided to stick with the approach into 24R. The crew was flexible and the CA did a nice job assigning workload. FO flew the plane while the CA checked everything over one more time (outstanding evaluation of plans). The crew was also better monitors and cross checkers. However, their execution of checklists was still a little sloppy — late and rushed (marginal monitor and cross check).

Bottom lines to Flare/Touchdown — The approach was stable, but the FO let the airplane slip left, which resulted in landing left of centerline. Since the FO was new to this aircraft (1 month flying time), the observer chalked it up to a lack of stick and rudder proficiency.

Taxi-in — The crew did a great job navigating taxiways and crossing the active 24L runway. Charts were out and both heads looking for traffic (outstanding taxiway/runway management). However, there were no wing walkers meeting the aircraft in a congested ramp area.

[A/C = Aircraft ATC = Air traffic control CA = Captain FMC = Flight management computer FO = First officer
SOP = Standard operating procedure TOD = Top of descent]

Overall Flight

Narrative	This narrative should include your overall impressions of the crew.

Overall, the crew did a marginal job with planning and review/modify plans during predeparture. However, during the descent/approach/land phase, it was excellent. Their execution behaviors were marginal to good for the entire flight.

While the takeoff brief was marginal, the CA made an outstanding approach brief. Open communication was not a problem. Good flow of information when the flight's complexity increased with the late runway change. They really stepped it up.

During predeparture, the CA introduced an unnecessary element of being rushed, which compromised workload management. However, his decisiveness and coordination in the descent/approach/land phase kept his leadership from being marked "marginal."

The big knock against this crew involved checklists, cross verifications, and all monitoring in general. They were a little too complacent during low workload periods (e.g., No altitude verifications during climb). The CA set a poor example in this regard. When the workload increased, the crew did a good job.

[CA = Captain]

Appendix

University of Texas Line Operations Safety Audit (LOSA) Observation Form With Sample Observations *(continued)*

Threat Management Worksheet

Threat ID	Threat Description			Threat Management	
	Describe the threat	Threat Type	Phase of Flight 1 Predepart/Taxi 2 Takeoff/Climb 3 Cruise 4 Des/App/Land 5 Taxi-in	Linked to flight crew error? (Yes/No)	How did the crew manage or mismanage the threat?
T1	*Runway and taxiway construction on their departing runway (final 2000').*	*103*	*1*	*No*	*Threat mismanaged — CA failed to include the construction and closures in his brief. No plans were made in the event of a rejected takeoff, which is required by airline SOP.*
T2	*Late ATC runway change — changed runway to 24R from 25L due to a slow moving aircraft on 25L.*	*101*	*4*	*Yes*	*Threat managed — CA reprogrammed the FMC, handled the radios, and placed emphasis on the FO to fly the aircraft.*
T3	*After a late runway change, ATC called back and told the crew that it was at their discretion to land on 24R or 25L.*	*101*	*4*	*Yes*	*Threat managed — CA asked for the FO's preference. They mutually decided to continue the approach into 24R because it was already in the FMC.*
T4	*On taxi-in, there were no wing walkers meeting the aircraft in a congested ramp area.*	*204*	*5*	*Yes*	*Threat managed — The crew called ground ops and wing walkers were dispatched to the airplane.*
T5					
T6					

Threat Codes

Environmental Threats		Airline Threats	
100 Adverse Weather	103 Airport Conditions	200 Airline Operational Pressure	204 Ground/Ramp
101 ATC	104 Heavy Traffic (air or ground)	201 Cabin	205 Dispatch/Paperwork
102 Terrain	199 Other Environmental Threats	202 Aircraft Malfunctions/MEL Items	206 Manuals/Charts
		203 Ground Maintenance	299 Other Airline Threats

[ATC = Air traffic control CA = Captain FMC = Flight management computer FO = First officer ID = Identification MEL = Minimum equipment list SOP = Standard operating procedure]

Appendix

University of Texas Line Operations Safety Audit (LOSA) Observation Form With Sample Observations *(continued)*

Error Management Worksheet

Error ID	Error Description				Error Response/Outcome		Error Management
	Describe the crew error	**Phase of Flight** 1 Predepart/Taxi 2 Takeoff/Climb 3 Cruise 4 Des/App/Land 5 Taxi-in	**Linked to Threat?** (If Yes, enter the Threat ID)	**Error Type**	**Crew Error Response** 1 Detected 2 No response	**Error Outcome** 1 Inconsequential 2 Undesired state 3 Additional error	**How did the crew manage or mismanage the error?**
E1	*CA failed to brief a rejected takeoff for shortened departing runway due to construction.*	*1*	*T1*	*403*	*2*	*1*	*No error management.*
E2	*FO failed to set his airspeed bugs.*	*1*		*304*	*2*	*3*	*Linked to error #3.*
E3	*In running the Before Takeoff Checklist, the FO skipped the takeoff data item.*	*1*		*401*	*2*	*2*	*Linked to UAS #1.*
E4	*At FL200, the crew was cleared to FL270. They accepted and the FO dialed 230 instead of 270 in the Mode Control Panel.*	*2*		*302*	*1*	*1*	*Error managed — Captain caught the error on cross-verification.*
E5	*FO, hand flying, let the airplane slip a little to the left during the final approach.*	*4*		*300*	*2*	*2*	*Linked to UAS #2.*

Error Type Codes

Aircraft Handling	Procedural	Communication
300 Manual Flying	400 SOP Cross-verification	500 Crew to External Communication
301 Flight Control	401 Checklist	501 Crew to Crew Communication
302 Automation	402 Callout	599 Other Communication
303 Ground Handling	403 Briefing	
304 Systems/Instruments/Radios	404 Documentation	
399 Other Aircraft Handling	499 Other Procedural	

[CA = Captain FL = Flight level FO = First officer ID = Identification SOP = Standard operating procedure UAS = Undesired aircraft state]

Appendix

University of Texas Line Operations Safety Audit (LOSA) Observation Form With Sample Observations *(continued)*

Undesired Aircraft State (UAS) Management Worksheet

UAS ID	*UAS Description*		*UAS Response/Outcome*			*UAS Management*
	Linking Error? (Enter the Error ID)	**Undesired aircraft state description**	**UAS Code**	**Crew UAS Response** 1 Detected 2 No response	**UAS Outcome** 1 Inconsequential 2 Additional error	**How did the crew manage or mismanage the undesired aircraft state?**
UAS 1	*E2*	*Wrong airspeed bugs on takeoff roll.*	*1*	*1*	*1*	*Errors mismanaged — The bug error should have been caught with the Before Takeoff Checklist, but the FO missed the item. The FO detected and corrected the error on the roll.*
UAS 2		*FO landed left of the centerline.*	*86*	*1*	*1*	*Error mismanaged — FO tried to correct but still landed left of the centerline. Approach was stable and made the first high-speed taxiway.*
UAS 3						

Undesired Aircraft State Type Codes

Configuration States

1 Incorrect A/C configuration — flight controls, brakes, thrust reversers, landing gear

2 Incorrect A/C configuration — systems (fuel, electrical, hydraulics, pneumatics, air-conditioning, pressurization, instrumentation)

3 Incorrect A/C configuration — automation

4 Incorrect A/C configuration — engines

Ground States

20 Proceeding toward wrong runway

21 Runway incursion

22 Proceeding toward wrong taxiway/ramp

23 Taxiway/ramp incursion

24 Wrong gate

25 Wrong hold spot

26 Abrupt aircraft control — taxi

Aircraft Handling States — All Phases

40 Vertical deviation

41 Lateral deviation

42 Unnecessary WX penetration

43 Unauthorized airspace penetration

44 Speed too high

45 Speed too low

46 Abrupt aircraft control (attitude)

47 Excessive banking

48 Operation outside aircraft limitations

Approach/Landing States

80 Crew induced deviation above G/S or FMS path

81 Crew induced deviation below G/S or FMS path

82 Unstable approach

83 Continued landing — unstable approach

84 Firm landing

85 Floated landing

86 Landing off C/L

87 Long landing outside TDZ

88 Landing short of TDZ

99 Other Undesired States

[A/C = Aircraft C/L = Centerline FMS = Flight management system FO = First officer G/S = Glideslope ID = Identification TDZ = Touchdown zone WX = Weather]

Appendix

University of Texas Line Operations Safety Audit (LOSA) Observation Form With Sample Observations *(continued)*

Crew Performance Marker Worksheet

1	2	3	4
Poor Observed performance had safety implications	**Marginal** Observed performance was adequate but needs improvement	**Good** Observed performance was effective	**Outstanding** Observed performance was truly noteworthy

		Phase of Flight Ratings		
Planning Performance Markers		**Predeparture/ Taxi**	**Takeoff/ Climb**	**Descent/Approach/ Land/Taxi**
SOP BRIEFING	The required briefing was interactive and operationally thorough.	2		4
PLANS STATED	Operational plans and decisions were communicated and acknowledged.	3		4
CONTINGENCY MANAGEMENT	Crew members developed effective strategies to manage threats to safety.	1		3
Execution Performance Markers				
MONITOR/CROSS-CHECK	Crew members actively monitored and cross-checked systems and other crew members.	1	1	2
WORKLOAD MANAGEMENT	Operational tasks were prioritized and properly managed to handle primary flight duties.	2	3	3
VIGILANCE	Crew members remained alert to the environment and position of the aircraft.	3	3	3
AUTOMATION MANAGEMENT	Automation was properly managed to balance situational and/or workload requirements.			3
TAXIWAY/RUNWAY MANAGEMENT	Crew members used caution and kept watch outside when navigating taxiways and runways.	3		4
Review/Modify Performance Markers				
EVALUATION OF PLANS	Existing plans were reviewed and modified when necessary.			4
INQUIRY	Crew members not afraid to ask questions to investigate and/or clarify current plans of action.	3		3

Overall Performance Markers		**Ratings**
COMMUNICATION ENVIRONMENT	Environment for open communication was established and maintained.	3
LEADERSHIP	Captain showed leadership and coordinated flight deck activities.	3

[SOP = Standard operating procedure]

Clear Air Turbulence, Downdraft Cited Most Often in U.S. Weather Turbulence Accidents, 1992–2001

No fatalities occurred as a result of weather turbulence in air carrier operations during the study period. Eight fatalities occurred in weather turbulence accidents in commuter and on-demand operations.

— FSF EDITORIAL STAFF

From 1992 through 2001, 4,326 weather-related accidents occurred in civil aviation in the United States. Of those accidents, 509 (11.8 percent) were categorized as weather turbulence accidents. The U.S. National Transportation Safety Board (NTSB) cited clear air turbulence most often as the cause or a causal factor in the weather turbulence accidents involving air carriers. Downdraft was cited most often in general aviation weather turbulence accidents.

NTSB reports of weather turbulence accidents included codes for various types of turbulence: downdraft; mountain wave; turbulence;[1] turbulence, clear air; turbulence, in clouds; turbulence, thunderstorms; updraft; turbulence, terrain-induced; and turbulence, convection-induced.

Turbulence and clear air turbulence were the types cited most often in weather turbulence accidents involving aircraft operated under U.S. Federal Aviation Regulations (FARs) Part 121 (air carriers). Downdraft was the type cited most often in weather turbulence accidents involving aircraft operated under FARs Part 135 (commuter and on-demand).

Those data, and the data that follow, are from a report of a study by analysts at the National Aviation Safety Data Analysis Center (NASDAC), part of the U.S. Federal Aviation Administration (FAA) Office of System Safety. Data were extracted from the NTSB Aviation Accident/Incident Data System. Causes and causal factors were those cited in final reports.

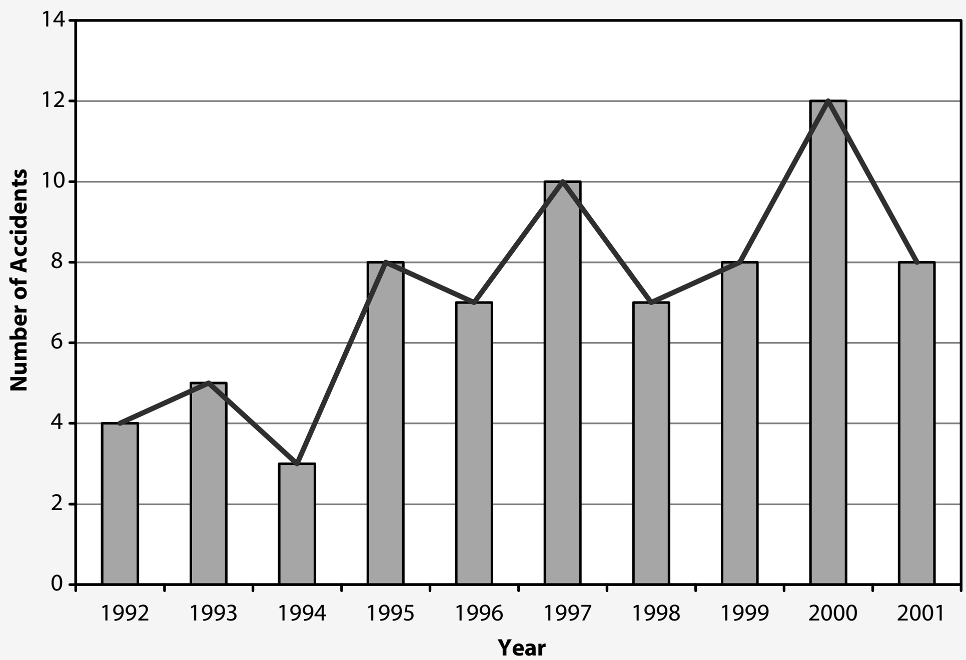
Downdraft was … cited most often in weather turbulence accidents involving aircraft operated under FARs Part 135.

Accidents Involving Turbulence: Part 121

The FARs Part 121 operations in the data are those of scheduled U.S.-based airlines and cargo carriers that fly large transport category aircraft.[2] Part 121 operations accounted for 72 (14 percent) of the 509 weather turbulence accidents. Variation by year is shown in Figure 1 and Table 1.

Some weather turbulence events were not included in this portion of the study because of the search criteria and data source used, the report said. Many of the Part 121 events in which a passenger or crewmember experienced minor injuries (such as a broken nose or a broken finger) in weather turbulence were not included because they did not meet the NTSB definition of an accident.[3]

Figure 1
Part 121 Weather Turbulence Accidents, by Year, 1992–2001



Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

Table 1
Part 121 Weather Turbulence Accidents, by Percentage, 1992–2001

Year	Number of Accidents	Percentage of Part 121 Weather Turbulence Accidents
1992	4	5.56%
1993	5	6.94%
1994	3	4.17%
1995	8	11.11%
1996	7	9.72%
1997	10	13.89%
1998	7	9.72%
1999	8	11.11%
2000	12	16.67%
2001	8	11.11%
Total	**72**	**100.00%**

Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

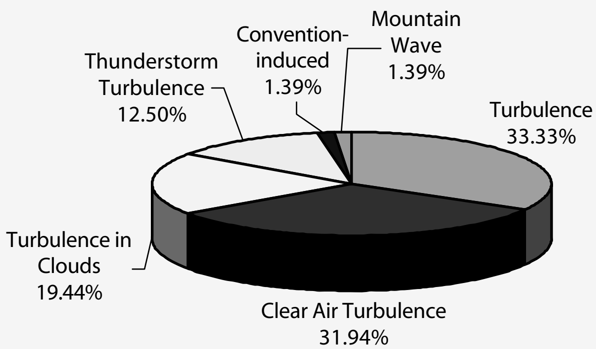
Table 2 and Figure 2 show the numbers and percentages of weather turbulence accident causes and causal factors cited by the accident investigator.

Table 2
Part 121 Weather Turbulence Accidents, By Type of Turbulence, 1992–2001

Type of Turbulence	Number of Citations
Turbulence	24
Clear Air Turbulence	23
Turbulence in Clouds	14
Thunderstorm Turbulence	9
Convection-induced	1
Mountain Wave	1
Total	**72**

Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

Figure 2
Part 121 Weather Turbulence Accidents, by Type of Turbulence, 1992–2001



Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

Table 3
Part 121 Total Weather Turbulence Injuries, by Type of Turbulence, 1992–2001

Type of Turbulence	Serious Injuries	Minor Injuries	Total Injuries
Turbulence	29	35	**64**
Clear Air Turbulence	27	25	**52**
Turbulence in Clouds	19	29	**48**
Thunderstorm Turbulence	12	27	**39**
Convection-induced	1	0	**1**
Mountain Wave	1	0	**1**
Total	**89**	**116**	**205**

Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

Turbulence and clear air turbulence accounted for the majority of the serious injuries. Table 3 shows the number of injuries sustained by the passengers and/or crewmembers aboard the aircraft by the type of turbulence.

Seventy-one (98.6 percent) of the 72 weather turbulence accidents involving Part 121 operations from 1992 through 2001 and investigated by NTSB resulted in serious injuries to passengers and/or crewmembers aboard the aircraft.

Georgia was the U.S. state with the most weather turbulence accidents involving Part 121 operations during the study period, with nine accidents. These weather turbulence accidents are listed by state in Table 4.

Table 4
Part 121 Weather Turbulence Accidents, By State, 1992–2001

State	Number of Accidents
Georgia	9
Florida	6
Illinois	5
California	5
Wisconsin	4
New Jersey	4
Colorado	4
Texas	3
Indiana	3
Oregon	3
New York	3
Michigan	3
Alaska	2
Missouri	2
North Carolina	2
Louisiana	2
Nevada	2
New Mexico	2
North Dakota	1
Massachusetts	1
Hawaii	1
Pennsylvania	1
South Carolina	1
Tennessee	1
Kansas	1
Virginia	1
Total	**72**

Note: States not listed had no Part 121 weather turbulence accidents during the study period.

Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

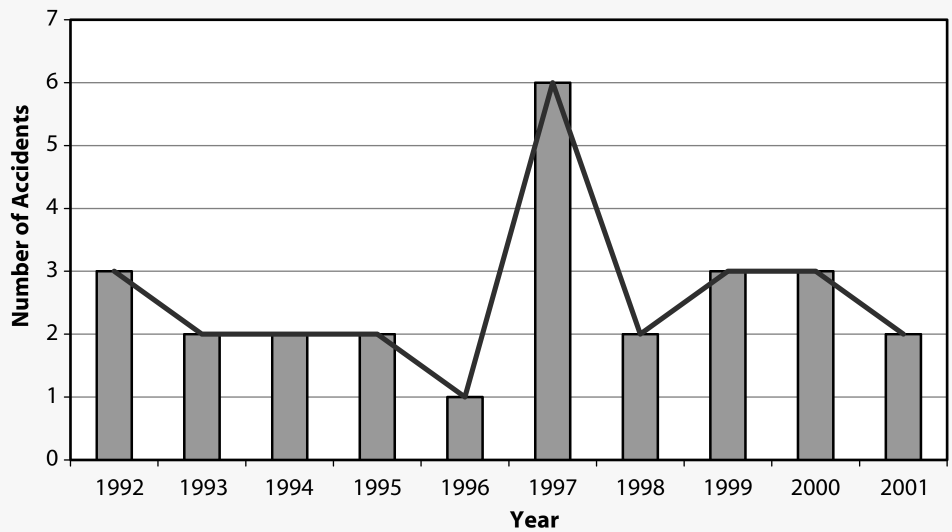
Accidents Involving Turbulence: Part 135

The FARs Part 135 operations in the data are those of scheduled (commuter) flights or nonscheduled (on demand/air taxi) flights. Scheduled Part 135 operations involve aircraft carrying nine or fewer passengers.[2] The data for nonscheduled operations also include cargo airplanes with payload capacities of 7,500 pounds (3,400 kilograms) or less.

According to NTSB final reports, weather turbulence during Part 135 operations accounted for 26 (5.1 percent) of the 509 total weather turbulence accidents (5.1 percent). Variation by year is shown in Figure 3 and Table 5.

Figure 4 and Table 6 (page 23) show Part 135 weather turbulence accidents by type of turbulence and by injury severity. A single accident could have more than one turbulence-related

Figure 3
Part 135 Weather Turbulence Accidents, by Year, 1992–2001



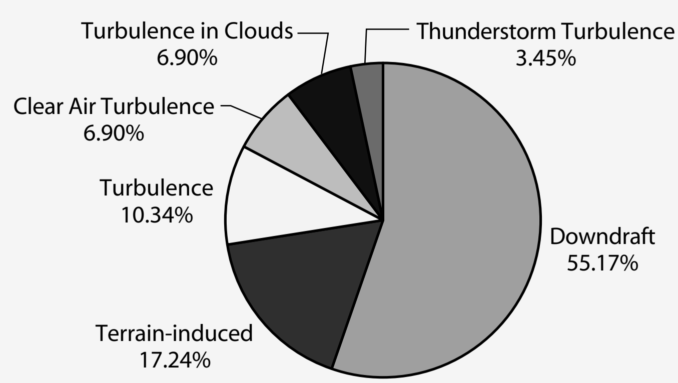
Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

Table 5
Part 135 Weather Turbulence Accidents, By Percentage, 1991–2001

Year	Number of Accidents	Percentage of Part 135 Weather Turbulence Accidents
1992	3	11.54%
1993	2	7.69%
1994	2	7.69%
1995	2	7.69%
1996	1	3.85%
1997	6	23.08%
1998	2	7.69%
1999	3	11.54%
2000	3	11.54%
2001	2	7.69%
Total	**26**	**100.00%**

Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

Figure 4
Part 135 Weather Turbulence Accidents, by Type of Turbulence, 1992–2001



Note: A single weather turbulence accident could have more than one turbulence cause or factor cited.

Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

Table 6
Part 135 Total Weather Turbulence Injuries, by Type of Turbulence, 1992–2001

Type of Turbulence	Fatal Injuries	Serious injuries	Minor Injuries	None	Total
Downdraft	2	1	4	9	**16**
Terrain-induced	2	1	1	1	**5**
Turbulence	0	0	1	2	**3**
Clear Air Turbulence	1	1	0	0	**2**
Turbulence in Clouds	2	0	0	0	**2**
Thunderstorm Turbulence	1	0	0	0	**1**
Total	**8**	**3**	**6**	**12**	**29**

Note: A single weather turbulence accident could have more than one turbulence cause or factor cited.
Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

cause or causal factor. For the 26 Part 135 aircraft involved in weather turbulence accidents, there were 29 turbulence-related causes and/or causal factors cited. Downdraft was the major weather turbulence factor in these Part 135 accidents, accounting for more than 50 percent of the total.

More than 50 percent of the Part 135 weather turbulence accidents occurred in the U.S. state of Alaska. These weather turbulence accidents are listed by state in Table 7.■

Table 7
Part 135 Weather Turbulence Accidents, By State, 1992–2001

State	Number of Accidents
Alaska	14
Colorado	2
Idaho	2
Utah	2
Arizona	1
Arkansas	1
California	1
Hawaii	1
South Carolina	1
Texas	1
Total	**26**

Note: States not listed had no Part 135 weather turbulence accidents during the study period.
Source: U.S. Federal Aviation Administration National Safety Data Analysis Center; U.S. National Transportation Safety Board

[This article is based on "Review of Aviation Accidents Involving Weather Turbulence in the United States, 1992–2001," dated August 2004, by FAA NASDAC. The report is available on the Internet at <www.nasdac.faa.gov>.

Notes

1. "Turbulence" was coded when the investigator did not provide any further specifics.

2. Since March 20, 1997, aircraft with 10 or more seats used in scheduled passenger service have operated under FARs Part 121. Prior to that date, some of those flights operated under FARs Part 135.

3. An *accident* is defined by NTSB as an event associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage.

   A *serious injury* is defined by NTSB as any injury that (1) requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received; (2) results in a fracture of any bone (except simple fracture of fingers, toes or nose); (3) causes severe hemorrhages, nerve, muscle or tendon damage; (4) involves any internal organ; or (5) involves second[-degree] or third-degree burns affecting more than 5 percent of the body surface.

   Substantial damage is defined by NTSB as damage or failure that adversely affects the structural strength, performance or flight characteristics of the aircraft, and would normally require major repair or replacement of the affected component.

Simplifying Processes and Tools Aids Project Risk Management

A qualitative methodology, such as posing and answering key questions, is often the best framework for project risk management; nevertheless, say the authors, quantitative analysis has its place as well.

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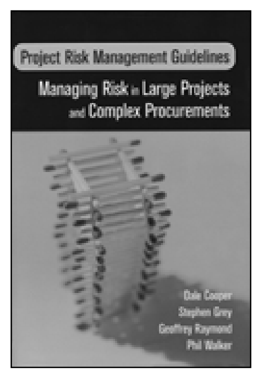
Books

Project Risk Management Guidelines: Managing Risk in Large Projects and Complex Procurements. Cooper, Dale F.; Grey, Stephen; Raymond, Geoffrey; Walker, Phil. Chichester, West Sussex, England: John Wiley & Sons, 2005. 384 pp. Figure, tables, glossary, references, index.

"One of the main lessons I learned from the finance sector, an industry that is often perceived as notoriously risky, is this: If something is too complex to understand and explain, then it is probably too risky to undertake, as you won't be able to design and implement the right kinds of operational processes, controls and monitoring to manage the risks effectively," says co-author Dale Cooper. "That insight … has led me to simplify many of the processes and tools I use for risk management. When complexity is needed, then it is really needed and it must be done properly, but simple approaches are often sufficient for making sound decisions. A large part of this book is based on simple qualitative approaches to project risk."

The goal of risk management is to identify and manage significant risks. The process can be conceived, the authors say, in terms of steps that involve answering relevant questions:

- Establish the context: "What are we trying to achieve?"
- Identify the risks: "What might happen?"
- Analyze the risks: "What might that mean for the project's key criteria?"
- Evaluate the risks: "What are the most important things?"
- Treat the risks: "What are we going to do about them?"



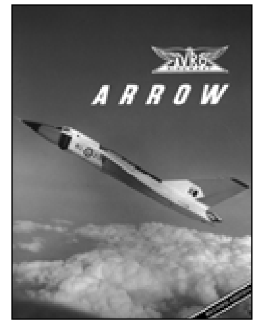
- Monitor and review: "How do we keep them under control?" and,

- Communicate and consult: "Who should be involved in the process?"

The first part of the book discusses in detail each of those steps, and is followed by consideration of related issues such as public-private partnerships, outsourcing and environmental-risk management. A chapter on "technical tools and techniques" describes such principles as hazard and operability studies, fault-tree analysis and rapid risk ranking and the inputs, outputs and documentation needed for each tool.

To illustrate the concept of a fault tree, the authors include a figure that illustrates the logical progression in troubleshooting an uncommanded cold shower using conceptual "gates" of either/or choices: "no hot water" vs. "mixer-tap fault"; "hot water [has been] consumed" vs. "water did not heat"; "no power" vs. "heater-element failure"; etc.

The authors conclude with a chapter on the quantification of project risks. "Quantitative risk assessments extend the process described earlier to more detailed numerical analysis of uncertainty, usually in the context of a model of the project being examined," say the authors. Quantitative analysis is particularly appropriate for tasks such as setting targets, evaluating the realism of estimates, selling a project proposal on the basis of confidence in the forecast outcome and choosing between alternative technologies with different risk profiles.



Avro Arrow: The Story of the Avro Arrow From Its Evolution to Its Extinction. Revised edition. The Arrowheads (Organ, Richard; Page, Ron; Watson, Don; Wilkinson, Les). Erin, Ontario, Canada: Boston Mills Press, 2004. 180 pp. Photographs, figures, bibliography, index.

The authors, who call themselves the Arrowheads, describe the Avro CF-105 Arrow — a long-range, twin-engine, all-weather jet interceptor — as "a plane without equal and considered by many to be 20 years ahead of its time." Donald H. Rogers says in his foreword that the Arrow was "Canada's outstanding achievement in aeronautical engineering, designing and manufacturing." During test flights, with its Orenda Iroquois engines, the aircraft reached a maximum speed of Mach 1.98.

The Arrow's first production model was rolled out in 1957. Its sponsor, the Canadian government, canceled the project in 1959. The five Arrows in airworthy condition, as well as others on the assembly line that were almost ready for flight, were ordered destroyed, as were engineering drawings and photographs — a decision that remains controversial.

The politics of the Arrow have been written about many times, the authors say, and their goal in this book was to document the aircraft's engineering, technical and flight-testing aspects before the absence of aircraft and scarcity of records cause it to fade from aviation history.

"We will attempt to unravel some of the mysteries about the Arrow and expose the reader to some of its lesser-known facets," say the authors. "We will take you from the Arrow's inception and early design studies to roll-out, and from flight test to the advanced proposals for the development of future versions. We will describe and show by pictures some of the action behind the scenes. … We have gathered together what we feel is a good historical record of many previously unpublished photos and information."

The book includes cut-away drawings of the Arrow's interior structure and components, including its weapons system (Sparrow 2 missiles). A technical illustration of the cockpit is labeled with numbered callouts that identify avionics. Photographs show the Arrow from many angles on the ground and in flight, and color photographs and diagrams indicate the various paint schemes applied to the aircraft.

Reports

Measures of Information Complexity and the Implications for Automation Design. Xing, Jing. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-04/17. October 2004. 15 pp. Figures, tables, references. Available on the Internet at <www.cami.jccbi.gov> or through NTIS.*

Modern air traffic control (ATC) automation tools are designed to help controllers identify potential conflicts between aircraft in a complex airspace structure and to provide controllers with decision-support tools. ATC automation tools are intended to ensure safety, to increase controllers' functional capacities and to relieve controllers from some tasks. In so doing, these tools can create new tasks associated with acquiring and integrating information from displays.

"The use of new tools requires that controllers integrate information from displays into their own methods of managing their cognitive resources," says the report. "Therefore, introduction of new systems can introduce additional complexity to task management." Likewise, if information provided by automation tools is too complex, cognitive capacities of controllers may become overwhelmed. As a result, key information could be overlooked or misinterpreted, and the risk of performance errors could increase.

"To evaluate the costs and benefits of an automation aid, it is important to understand how much information is shown on the display, how users look at multiple information sources to build and maintain situation awareness, and whether the information is displayed in a compatible way so it can be integrated and understood easily without the user having to make internal conversions or calculations," says the report.

The report answers the question "How can users evaluate the benefits and disadvantages of information systems and displays for controllers?" by exploring three basic questions:

- What is complexity?
- Why can information in an automation display be too complex for the human brain to process?
- How is complexity of visual displays quantified?

The report presents a framework for developing metrics for information complexity in automation displays. It also describes a specific set of metrics that can be used to assess the complexity of ATC automation displays, to evaluate new systems and to serve as guidelines for interface design.

Regulatory Materials

Radiotelephony Manual. U.K. Civil Aviation Authority (CAA) Safety Regulation Group (SRG). Civil Aviation Paper (CAP) 413, Edition 15, including amendment 1/04. Dec. 17, 2004. 177 pp. Table, diagrams, appendix, glossary, bibliography, index. Available on the Internet at <www.caa.co.uk> or from Documedia.**

CAP 413 is a compendium of clear, concise, standardized phraseology and recommended guidelines for use by pilots and U.K. Air Traffic Services personnel during radiotelephony (RTF) communications within U.K. airspace. Phraseology in this manual was established to ensure uniformity in RTF communications and to reduce or eliminate ambiguity.

Air traffic controller phraseology appearing in this document is consistent with phraseology published in the U.K. *Manual of Air Traffic Services*, CAP 493. RTF communications associated with operational details appear in the U.K. *Aeronautical Information Publication* (AIP).

The U.K. RTF manual is based on international standards and recommended practices (SARPS) contained in International Civil Aviation Organization (ICAO) Annex 10, volume 2, "Communications Procedures"; ICAO Doc. 4444, *PANS-ATM, Procedures for Air Navigation Services — Air Traffic Management*; and other ICAO documents.

For quick reference, the manual is divided into chapters; each chapter is devoted to appropriate phraseology for specific situations and events. Some are listed below with examples:

- General procedures in RTF (transmitting techniques);
- Airport control service (aircraft takeoff clearance and movement instructions to vehicle drivers);

- Radar (vectoring);
- Approach (instrument flight rules departure);
- Area control service (position reporting); and,
- Distress and urgency communication procedures (states of emergency).

With regard to the manual, the U.K. CAA says, "Where the ICAO standard phraseology may be misunderstood, or has weaknesses in the U.K. environment, different phraseology has been specified for use (and notified to ICAO). In the United Kingdom, air traffic service units and pilots are expected to comply with the phraseology and procedures described in the main text of this document."

The CAA says, "When communicating with air traffic service units in other [ICAO] States, pilots should use phraseology and procedures set out by ICAO (subject to any differences notified by that State)."

The RTF manual says that the U.K. CAA has identified "significant differences between the ICAO standard phraseology and that specified for use in CAP 413." Following is one of 19 specific differences noted in the manual.

The manual says, "The phrase GO AHEAD (ICAO) is not used in the United Kingdom. In the United Kingdom, the term PASS YOUR MESSAGE is used." The reason given for the change, as noted, is: "GO AHEAD is not used on safety grounds (e.g., to reduce runway incursions) where some pilots/drivers might confuse GO AHEAD with PROCEED."

CAP 413 contains useful information for those studying for the U.K. flight RFT operator's license examination. Candidates for European Joint Aviation Authorities (JAA) pilot license and instrument rating examinations should be aware, however, that the syllabus for the communications exam is based on ICAO documents, not on CAP 413.

U.S. Airworthiness Certificates and Authorizations for Operation of Domestic and Foreign Aircraft. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 20-65A. July 8, 2004. Table, references. 6 pp. Available from FAA via the Internet at <www.faa.gov> or from the U.S. Department of Transportation (USDOT).***

The AC provides general information on applications for standard certificates and special airworthiness certificates for U.S.-registered aircraft. It discusses procedural steps and required documentation that production approval holders and individual owners of civil aircraft need.

Non-U.S. aircraft operating in the United States without standard airworthiness certificates issued by the country of registry may apply for special flight authorization (SFA) from FAA. The AC discusses conditions that require an SFA, and lists procedural steps for obtaining one.

The AC says, "A civil aircraft registered in a country that is a member of the International Civil Aviation Organization (ICAO) needs only a special flight authorization issued by the FAA. A civil aircraft registered in a country that is not a member of ICAO always requires an authorization from the USDOT and a special flight authorization issued by the FAA to operate in the United States."

[This AC cancels AC 20-65, *U.S. Airworthiness Certificates and Authorizations for Operation of Domestic and Foreign Aircraft*, dated Aug. 11, 1969.] ■

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Springfield, VA 22161 U.S.
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37 Windsor St.
Cheltenham, Gloucester GL52 2DG U.K.
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Subsequent Distribution Office, M-30
Ardmore East Business Center
3341 Q 75th Ave.
Landover, MD 20785 U.S.

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Overflowing Sink Blamed for Short Circuit, Fumes in B-717

The accident report said that an electrical odor in the cabin during a domestic flight in Australia led to an unscheduled landing.

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The following information provides an awareness of problems through which such occurrences may be prevented in the future. Accident/incident briefs are based on preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be entirely accurate.

AIR CARRIER

Accident Drew Attention to Training Anomaly

Boeing 717. Minor damage. Eight minor injuries.

As the crew was preparing for a domestic flight in Australia, cabin crewmembers observed water spilling from a sink in the aft left lavatory. They told the flight crew, the spill was cleaned up, and the lavatory was locked and placarded to prevent its use.

During cruise at Flight Level 320 (approximately 32,000 feet), the cabin crew smelled a faint electrical odor in the rear of the passenger cabin. They told the flight crew about the odor. Soon afterward, they told the flight crew that the handset on the cabin interphone near the aft left lavatory was hot, that the electrical odor was becoming stronger and that the aft cabin interphone handset flexible-wiring loom was "melting," the accident report said.

The flight crew conducted the quick reference handbook "Non-normal" checklist for "Electrical Smoke/Fumes of Unknown Origin," donned oxygen masks and selected emergency electrical power. They declared pan-pan, an urgent condition, and diverted to an en route airport, where aircraft rescue and fire fighting personnel met the airplane. The odor had dissipated, the interphone was no longer hot, and there was no smoke. The airplane was taxied to the terminal, where passengers deplaned through the forward door. Eight people in the airplane were treated for smoke/fumes inhalation.

An investigation revealed that the "miscellaneous cabin and lavatory-occupied aft" electrical circuit breaker had been activated (tripped) and could not be reset because of a short circuit in a connecter plug under the lavatory sink.

"Water from the overflowing basin had seeped into the connector plug," the report said. "The short circuit within the connector plug resulted in several pins within the plug becoming welded together. As a consequence, the aft cabin interphone handset flexible-wiring loom was overheated from [an] overcurrent within the loom and resulted in the in-flight electrical smell and overheating of the handset."

After the damaged components were replaced, the airplane was returned to service.

After the incident, the flight crew said that the landing gear "DOWN" indication in the airplane was different than the indication in the flight simulator that had been used during training for flight using emergency electrical power. The operator's investigation determined that the simulator indication was incorrect; the manufacturer subsequently ordered software changes in B-717 flight simulators to correct the problem.

The manufacturer also was reviewing "failure conditions that can affect lavatory hand-basin water-shutoff mechanisms; design, panel assembly and installation of B-717 aft cabin interphones; electrical installations associated with B-717 aircraft lavatory modules; [and] lavatory faucet reliability data," the report said.

Collision With Deicing Vehicle Unnoticed by Crew

Boeing 747. Minor damage. No injuries.

Nighttime instrument meteorological conditions, including dense fog, prevailed during preparations for the flight from France to United Arab Emirates. The flight crew taxied the airplane along a taxiway toward the departure runway. The taxiway was adjacent to a deicing area, and the crew taxied into the area "without any intention to deice," the accident report said.

The airplane's right wing struck a deicing vehicle. The flight crew did not realize what had happened and continued taxiing; they flew the airplane to its destination without further incident.

About 90 minutes after takeoff, deicing personnel observed damage to the deicing vehicle and notified the air traffic control tower. Several hours later, the operator's personnel at the airport in United Arab Emirates observed damage on an airplane arriving from France and notified authorities at the departure airport.

The report said that causes of the incident were "the incorrect positioning of a deicing vehicle left without its driver" and "the [flight] crew's incorrect perception of the dimensions of the obstacle in a difficult environment in terms of lighting."

Contributing factors were "the positioning of the [deicing vehicle's] control cabin in the high position; the fact that the deicing vehicle's flashing light was not at the highest point on the vehicle, whereas the crew thought this to be the case, leading the pilots to estimate that the wing would not collide with the obstacle; the … undefined procedure for pre-positioning the deicing vehicles; incomplete and imprecise documentation on the deicing zones; [and] the absence of checks on the positioning of vehicles in the procedures for setting up the deicing areas."

Windshield Wiper Fails During Approach in Heavy Rain

McDonnell Douglas MD-83. Substantial damage. No injuries.

Nighttime instrument meteorological conditions prevailed for the approach to an airport in Northern Ireland following a charter flight from Portugal. After the flight crew established the airplane on the instrument landing system (ILS) approach to Runway 26, a controller in the airport air traffic control tower told them that heavy rain was falling at the airport and thunderstorms were in the area.

About 50 feet above the decision height of 400 feet, the crew observed the runway approach lights and switched on the aircraft's windshield (windscreen) wipers. After a few strokes, the wiper blade on the captain's side loosened, and the wiper was no longer usable.

The crew continued the approach and, between 30 feet above ground level (AGL) and 60 feet AGL, "the pilots were surprised by the aircraft suddenly drifting to the right," the report said. The airplane touched down right of the runway centerline, and the right main landing gear and nose landing gear rolled off the edge of the runway. The captain steered the airplane back onto the runway and taxied to the station area, where passengers deplaned normally.

The investigation revealed that weather information available to the pilots was four hours old and that they had not been told about deteriorating weather conditions until about nine minutes before landing. Had they been told earlier, they "would probably have been better prepared for a possibly difficult landing in darkness with heavy rain, thunder and poor extraneous visual references," the report said.

Visibility just before touchdown probably was about 1.5 kilometers (0.9 statute mile), and high-intensity approach lights and runway lights were set to 3 percent of their intensity, so "it is reasonable to assume that the pilots' visual references for the landing were compromised," the report said.

"When the windscreen wiper on the pilot-in-command's side stopped working, the situation became further aggravated. He was forced to decide quickly whether he should [reject the landing] or complete the landing, or have the copilot take control and land the aircraft. In the situation then prevailing, however, it was probably too late to hand over control to the copilot."

The report said that the cause of the accident was the "degree of difficulty to perform the landing increasing at a rate that the pilots did not fully realize in time." Contributing factors were that "the pilots were not prepared for the prevailing weather situation; the landing took place in darkness with a low cloud base, in poor visibility, in heavy rain, with few extraneous visual references; the pilot-in-command's windscreen wiper did not function; the high-intensity approach and runway lights were set to the standard setting of low intensity; at approximately the time of disconnection of the autopilot, the aircraft suffered a roll disturbance; [and] there may have been local turbulence or wind shear."

The report recommended international harmonization of light-setting standards for high-intensity approach lights and runway lights and that periodic functional checks of aircraft windshield wipers be conducted "under load."

Hydraulic-system Contamination Found After Uncommanded Spoiler Extension

De Havilland DHC-7 Dash 7. No damage. No injuries.

The airplane was being flown on a domestic flight in Liberia and was in a left turn onto the final approach course when there was an uncommanded extension of the right roll spoilers. The flight crew applied power, retracted the spoilers and completed the approach and landing.

During a preliminary investigation, the operator found contamination in the no. 2 hydraulic system. A preliminary report said that the contamination might have resulted from the failure of the no. 2 hydraulic pump about two weeks before the incident.

Maintenance personnel replaced the right roll spoiler and sent the removed spoiler to the manufacturer for further examination. The airplane's hydraulic filters were replaced and its hydraulic systems were flushed before the airplane was returned to service.

Change in Refueling Pattern Preceded In-flight Loss of Engine Power

Piper PA-24-250 Comanche. Substantial damage. One serious injury.

Daytime visual meteorological conditions prevailed for the departure from an airport in the United States on the second leg of a round-trip flight. The pilot said that he selected the left main fuel tank for the takeoff and that about 200 feet above ground level, the engine stopped producing power.

The pilot verified that the electric fuel pump was on and that the mixture was rich, then switched to the right main fuel tank and back to the left main fuel tank. He conducted an emergency landing in a field about 0.5 nautical mile (0.9 kilometer) south of the airport in a residential area. The airplane struck trees and then struck terrain.

A preliminary report said that earlier in the day, before the first leg of the flight, the pilot had asked airport personnel to pull the airplane from its hangar and to add fuel so that the fuel tanks were full.

"Upon arriving at [the airplane], the pilot realized the airplane had not been refueled," the report said. "The pilot stated that he was running late and elected to have [airport refueling personnel] fill only the left [auxiliary fuel tank] and right auxiliary fuel [tank]. After refueling, he noted that the right main fuel tank and left [auxiliary fuel tank] and right auxiliary fuel [tank] were full and there were 'only a few gallons' in the left wing fuel tank."

The pilot selected the right auxiliary fuel tank for the first leg of the round-trip flight and selected the left main fuel tank before landing. Before departure on the second leg of the flight, the pilot (who said that when he refueled the airplane, he always ensured that both main fuel tanks were full) "subconsciously thought the left man fuel tank was full," the report said.

The company that recovered the airplane said that about four tablespoons (59 milliliters) of fuel had been drained from the left fuel tank.

Unoccupied Ground Vehicle Strikes Parked Airplane

Raytheon Beechjet 400A. Substantial damage. One minor injury.

Daytime visual meteorological conditions prevailed when the airplane, which was parked at an airport in the United States, was struck by a ground service vehicle.

The operator of the vehicle said that he was driving toward the airplane, after the pilots started the engines, to unplug a ground power unit. A tow bar that had been placed on the vehicle began to slide off, and the operator tried to "grab the tow bar and steer the vehicle at the same time but fell off the vehicle onto the ground," a preliminary accident report said. "The unoccupied vehicle continued towards the airplane, striking the right wing."

Fuel Exhaustion Prompts Emergency Landing

Robin DR 400. Substantial damage. One minor injury.

Visual meteorological conditions prevailed for the flight from Germany to the Netherlands. About 90 minutes after takeoff, the pilot radioed air traffic control (ATC) and said that he wanted to divert to a nearby airport because of a possible fuel shortage. ATC said that the airport he had suggested was closed but that another nearby airport was open.

The final accident report said that the pilot altered his course, radioed the airport air traffic control tower that he was flying the airplane on an approach to landing "due to low fuel, because of minimum fuel" and received clearance to fly the airplane over a populated area at 1,500 feet. The engine then stopped, and the pilot "realized that he was too low to reach the runway and reported 'running out of fuel present time.'" He landed the airplane in a field about two minutes later — about one hour and 55 minutes after takeoff.

The pilot said that the fuel tanks, which held 110 liters (29 U.S. gallons), had been full at takeoff. The report said that 110 liters should have been enough for a three-hour flight and that the investigation did not determine why the fuel tanks were empty within two hours.

"It could not be determined if the 'FUEL LOW' warning system had generated an indication in the cockpit when 25 liters [seven gallons] remained in the tank," the report said. "It was also not possible to prove that the tank was full at departure."

Nosewheel Collapses During Test-flight Landing

Van's RV-6A. Minor damage. No injuries.

The pilot conducted a 95-minute test flight on the experimental airplane before returning to land the airplane at an airport in England. The flight was the second flight of the day; the landing was the ninth landing since the airplane was first flown.

The pilot said that he considered the landing a "good landing" and that as he adjusted the throttle for full power to conduct a touch-and-go, he heard a "grating" sound and rejected the takeoff. After he exited the airplane he observed that the nose leg was bent and that "the yoke carrying the nosewheel had 'tucked under' (rotating rearwards) so that the nose of the aircraft was resting on this yoke," the accident report said.

The RV-6A is a nosewheel airplane that was developed from the RV-6, a tailwheel airplane. The nosewheel consists of a "steel leg attached to the engine mount and protruding forward to a free-castoring yoke and nosewheel," the report said. Metallurgical tests showed that the nose leg met the design specification.

"It is likely that the leg was deflected by a vertical load at some point along the runway," the report said. "Reports from a number of eyewitnesses suggest that the nose leg may have been subjected to a higher vertical load during the attempted touch-and-go sequence than the pilot appreciated, causing deflection so that the yoke contacted the runway surface."

Two similar airplanes were involved in previous accidents in which the nose leg collapsed, the report said.

Gusty Wind Flips Taxiing Airplane

Cessna 182D. Substantial damage. No injuries.

As the pilot taxied the airplane at an airport in Canada, the wind flipped the airplane onto its back.

A preliminary report said that the wind velocity was 39 knots, gusting to 52 knots. The report did not mention wind direction.

ROTORCRAFT

Pilot Becomes 'Disoriented' While Wearing Night Vision Goggles in IMC

Eurocopter AS 350B3. Destroyed. No injuries.

Nighttime instrument meteorological conditions (IMC) prevailed for the flight in the United States. A preliminary report said that about 25 minutes after takeoff, the pilot, who was wearing night vision goggles, became disoriented. After he removed the goggles, the helicopter struck a mesa (a hill with steep walls and a relatively flat top).

Weather at an airport 15 nautical miles (28 kilometers) northwest of the accident site included visibility of 0.8 statute mile (1.3 kilometers) and a 200-foot overcast.

Pilot Blames Lack of Markings For Wire Strike After Takeoff

Bell 47G. Destroyed. One minor injury.

Daytime visual meteorological conditions prevailed during preparations for a locust-spraying flight in Australia. As the pilot repositioned his helicopter for preflight loading, he conducted an air taxi around another helicopter that was ready for departure.

The pilot said that he observed a pole about 300 meters (984 feet) away but that he had forgotten about power cables located 50 meters (164 feet) away and at treetop level. The helicopter struck the power cables.

The pilot said later that if the power cables had been marked, he would have seen them and would have avoided them. After the accident, the power company installed overhead markers to the repaired power cables.

Helicopter Strikes Mountain After Rejected Landing

Eurocopter SA 315B Lama. Substantial. Five minor injuries.

The helicopter was being flown on a heli-skiing flight in India, transporting four passengers to a hilltop. About one nautical mile (1.9 kilometers) before landing, the pilot felt a gust of wind; during the final pre-landing check, he rejected the landing because he was using more power than required, the accident report said.

As he flew the helicopter over a ridge to the south, the helicopter descended and struck a mountain. The report said that the cause of the accident was "the decision of the pilot to [reject the] landing while in the shallow approach, and turning to the right caused stalling of the rotor blades, resulting in sinking of the helicopter and impacting … the mountain."■

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