Flight Safety

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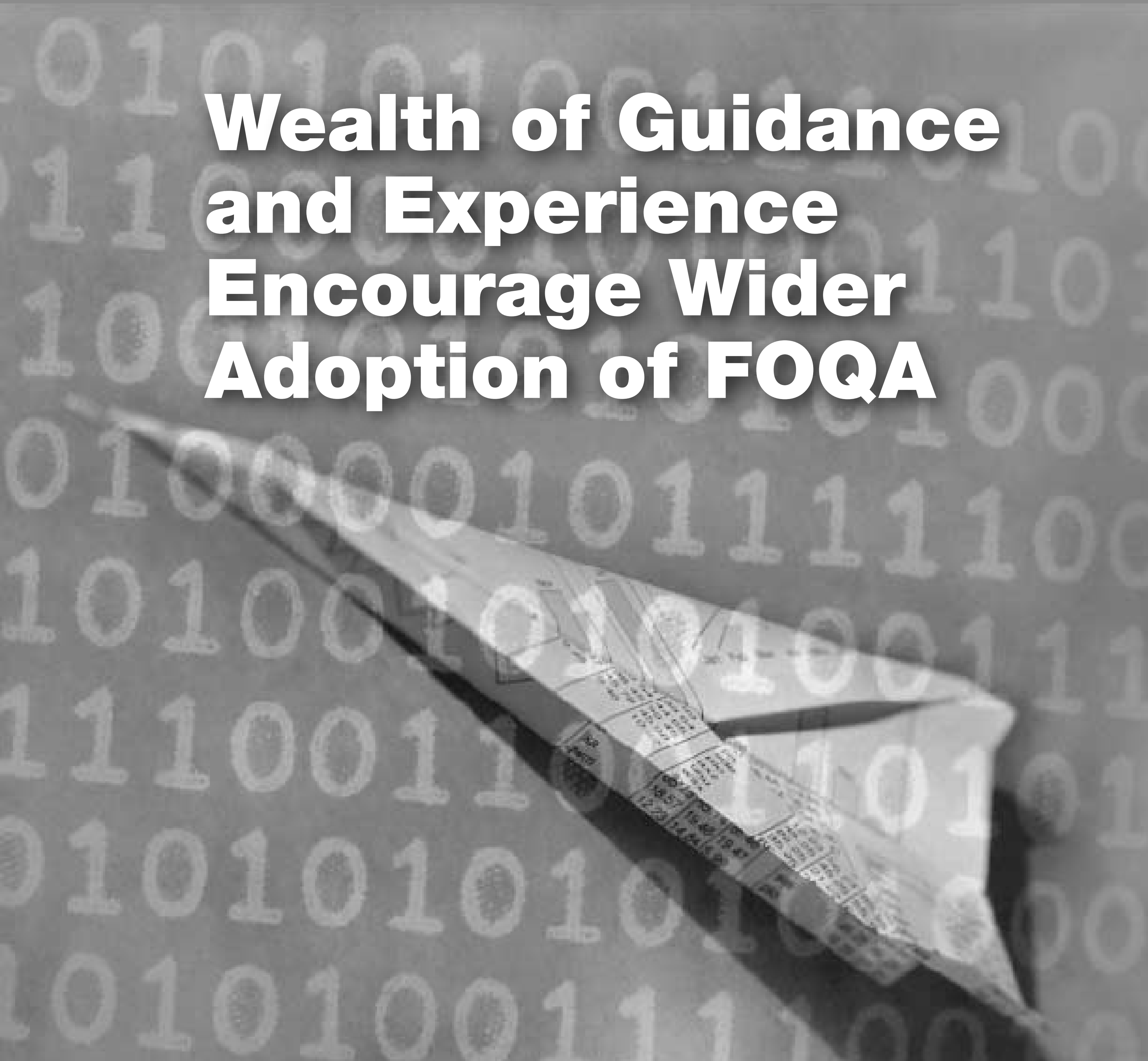
Wealth of Guidance and Experience Encourage Wider Adoption of FOQA



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 910 member organizations in more than 142 countries.

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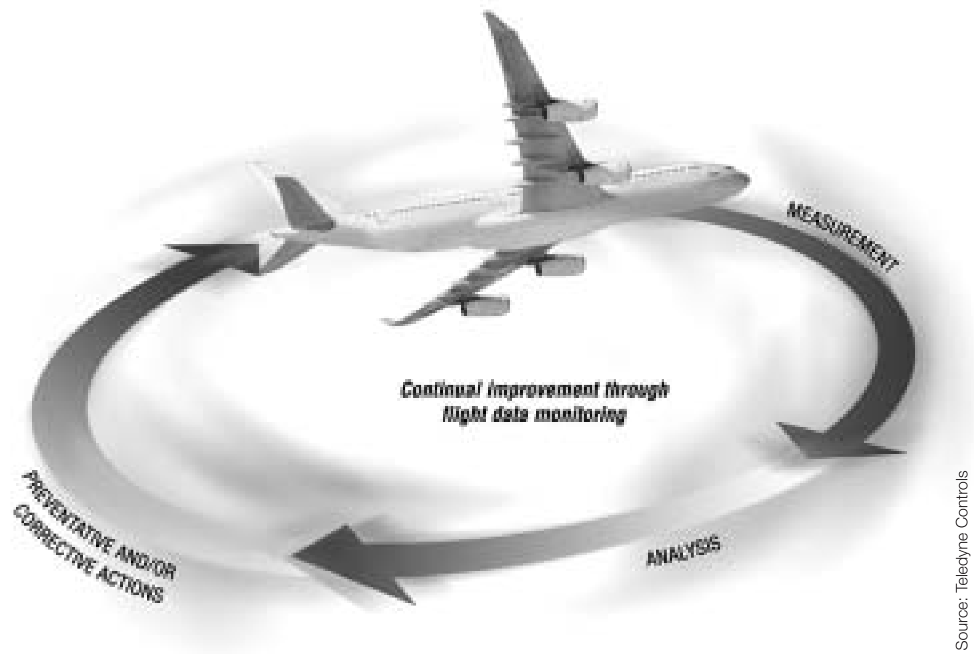
Wealth of Guidance and Experience Encourage Wider Adoption of FOQA

On Jan. 1, 2005, nonpunitive flight-data monitoring will become an international standard for operators of some commercial transport aircraft. Air carriers that already have established flight operational quality assurance programs have turned them into indispensable risk-management tools.

— FSF EDITORIAL STAFF



Source: Teledyne Controls

Air carriers have many incentives to learn safety lessons from analyzing data recorded during routine flight operations — not from accidents — international specialists said in the context of the April 2004 publication of a U.S. Federal Aviation Administration (FAA) advisory circular (AC) about flight operational quality assurance (FOQA, also called flight-data monitoring; see "Flight Operational Quality Assurance," page 23). Flight Safety Foundation (FSF) had said in a 1993 study that FOQA programs have provided one of the most powerful safety tools available, but also that "data-protection issues are so critical to the acceptance and success of FOQA that … such issues must be resolved before FAA releases an advisory circular on FOQA."[1] Guidance documents from other countries — such as the U.K. Civil Aviation Authority's 2003 Civil Aviation Publication 739, *Flight Data Monitoring* — also provide information for air carriers to consider.

By the FSF definition, FOQA programs obtain and analyze data recorded in flight operations to improve flight crewmembers' performance, air carrier training programs, operating procedures, air traffic control (ATC) procedures, airport maintenance and design, and aircraft operations and design. They typically use quick-access recorders (QARs) to obtain data for hundreds or thousands of flight parameters, but also may use digital flight data recorders (DFDRs), wireless data-transmission systems or other storage media and methods. When QARs are used, flight data are retrieved during routine station stops and processed by computer software to identify, at a minimum, any deviations or exceedances from the expected flight parameters. More sophisticated types of data analysis have evolved among the world's most experienced air carriers.

Although a few U.S. air carriers had established FOQA programs during the 1990s under an FAA policy providing protection from enforcement actions based on FOQA data, the federal law on protection of voluntarily submitted information was enacted in 1996, and related U.S. Federal Aviation Regulations (FARs) became effective beginning in 2001. The FOQA AC provides the most complete guidance yet for U.S. air carriers on acceptable methods of establishing a FOQA program with all of the available regulatory protections. Its publication means that they have an unprecedented opportunity to establish FOQA programs with less concern about issues that had been impediments to some air carriers.

The Foundation expects that as early as 2006, FOQA might be proven to be a feasible tool for operators of corporate turbojet aircraft (see "Flight Plan for Corporate FOQA: Aircraft Wanted," page 4).

International opinion has shifted toward viewing FOQA as a safety method that should be mandatory rather than voluntary.

In recent years, however, international opinion has shifted toward viewing FOQA as a safety method that should be mandatory rather than voluntary. The 188 contracting states of the International Civil Aviation Organization (ICAO) have agreed that "a flight-data analysis program," on a nonpunitive basis with protection of data sources, will become a standard for some commercial transport aircraft beginning Jan. 1, 2005 (see "DFDR Specialists Prompt ICAO Data-monitoring Standard," page 3). "Nonpunitive" means that information obtained from FOQA would not be used, for example, as the basis for an air carrier to take disciplinary action against a pilot or for a civil aviation authority to apply regulatory sanctions against an air carrier. "Protection of data sources" means that data could not be disclosed publicly or for purposes other than aviation safety.

The Global Aviation Information Network (GAIN) *Operator's Flight Safety Handbook* said in 2002 that the main objective of a FOQA program is to improve safety by identifying trends, not individual acts.[2]

"The purpose of a FOQA program is to detect latent patterns of behavior among flight crews, weaknesses in the ATC system and anomalies in aircraft performance which portend potential aircraft accidents," GAIN said. "A successful FOQA program encourages adherence to standard operating procedures (SOPs), deters nonstandard behavior and so enhances flight safety."

Air carriers with FOQA programs have used flight data to identify problems such as unstabilized approaches and rushed approaches; exceedance of flap limit speeds; excessive bank angles after takeoff; engine over-temperature events; exceedance of recommended speed thresholds; ground-proximity warning system (GPWS)/terrain awareness and warning system (TAWS) warnings; onset of stall conditions; excessive rates of rotation; glide path excursions; and vertical acceleration.

FOQA programs worldwide can be traced to pioneering work by British Airways and TAP Air Portugal in the early 1960s and to many non-U.S. airlines that shared their expertise during FSF seminars and workshops in the 1980s and 1990s. Fully operational programs had been established by about 70 air carriers worldwide as of September 2002, and another 50 air carriers then were at various stages of establishing programs, a U.K. study said.[3] By comparison, the 1993 FSF study had found approximately 25 air carriers with FOQA-like programs.

Historically, some air carriers were deterred because they perceived FOQA as relatively expensive in initial capital costs of hardware and operational costs, to include computer software and specialized personnel. Others cited concerns about the potential for unintended uses of flight data. The Foundation's position has been that what air carriers without FOQA miss is detailed knowledge of how their aircraft are being operated — knowledge that can prevent an accident — and capability to compare a specific flight with a fleet profile to analyze systemic aspects of flight operations.

DFDR Specialists Prompt ICAO Data-analysis Standard

The idea for an ICAO standard and recommended practice (SARP) for flight-data monitoring was discussed at the ICAO Flight Data Recorder Panel divisional meeting in November 1998 and resulted in a working paper by the ICAO Secretariat, said Michel Béland, technical officer, ICAO Operations/Airworthiness Section. ICAO then was asked to take steps to promote flight-data monitoring as part of an operator's accident prevention and flight safety program.[4]

Proposed Amendment 26 to the SARPs in Annex 6, Part 1, was drafted during the ICAO Accident Investigation and Prevention divisional meeting in September 1999 and was circulated to ICAO contracting states. Most states supported the proposed amendment; the ICAO Air Navigation Commission then recommended adoption; and the ICAO Council adopted the amendment in 2001, Béland said. The final amendment recommended effective Jan. 1, 2002, flight-data monitoring for aircraft with certificated takeoff weight of more than 20,000 kilograms (44,000 pounds) and established a standard requiring flight-data monitoring effective Jan. 1, 2005, for aircraft with certificated takeoff weight of more than 27,000 kilograms (60,000 pounds).

"This standard has been under discussion by the Flight Data Recorder Panel and circulating since the early 1990s," Béland said. "Essentially, the key driver was to have a proactive approach to safety where operators are in a position to identify undesirable trends and take corrective measures before an incident or accident occurs. Quite a number of operators of large transport jets already have been doing this with some very positive results, including improved fuel efficiency. Those with very long experience have said that this is the best safety program they ever have implemented.

Gabriel Gregio, safety analyst for TAM Brazilian Airlines, uses computer software to quickly identify apparent exceedances of predetermined aircraft operating parameters. (FSF Photo)

"This amendment also was a compromise so as not to impose an undue burden cost-wise on the operators of smaller aircraft. Nevertheless, the standard made the 'flight-data analysis program' mandatory for contracting states as of the effective date; if states do not comply, they are required to notify a difference to ICAO [i.e., to formally state that they do not comply with the SARP]." The SARP explicitly mandates that such programs be nonpunitive and contain safeguards to protect the data sources.

Consistent with these ICAO SARPs, the European Joint Aviation Authorities in June 2004 adopted its notice of proposed amendment (NPA), NPA OPS–35, *Flight Data Monitoring,* to Joint Aviation Requirements–Operations (JAR–OPS) 1.037, *Accident Prevention and Flight Safety Programme.* Effective Jan. 1, 2005, the amendment mandates that flight-data-monitoring programs be established and utilized on airplanes having a maximum certificated takeoff weight greater than 27,000 kilograms. A new advisory circular joint (AJC), AJC 1.037(b), *Flight Data Monitoring Programme,* will provide guidance information for European air carriers.

FSF President Sees Limits Affecting Voluntary FOQA

For U.S. air carriers, the decision to establish a FOQA program is voluntary, although FAA approval of the FOQA program is required to

Continued on page 6

Flight Plan for Corporate FOQA: Aircraft Wanted

Flight Safety Foundation (FSF), a leading advocate of flight operational quality assurance (FOQA) worldwide and a catalyst in the early 1990s for the establishment of air carrier FOQA programs in the United States,[1] currently is seeking operators of corporate aircraft with digital data buses to participate in a one-year demonstration program to explore the adaptation of this proven safety tool for corporate aircraft operators.

As of June 8, 2004, 15 operators had expressed interest in participating in the corporate FOQA (C-FOQA) demonstration program, which will begin in January 2005; five operators, including one in Europe, that operate nine airplanes had committed to participating. The goal is to have at least 25 airplanes involved in the demonstration program.

"The Foundation encourages any operator that has an airplane equipped with a digital data bus and a digital flight data acquisition unit to participate in the demonstration program," said Robert H. Vandel, FSF executive vice president.[2]

"Many air carriers have embraced FOQA as a means to further improve an already excellent safety record," Vandel said. "We are working to make this tool available to corporate aviation operators. We believe that there are many applications of FOQA for corporate aviation, with the only limitation being our imagination."

The C-FOQA program is being conducted by the FSF Corporate Advisory Committee (CAC) with the National Business Aviation Association (NBAA) Safety Committee. The genesis of the program was a 1999 recommendation by the FSF Approach-and-landing Accident Reduction (ALAR) Task Force for more widespread use of flight-data-monitoring programs such as FOQA.[3]

The task force said that safety-improvement efforts largely have been based on the findings of accident investigations, which provide only partial answers to the question of what efforts should be initiated or supported to improve safety.

"Without data, efforts to reduce the accident rate represent only guesses as to how best to allocate resources," the task force said.

Among specific recommendations was the development of a process to bring FOQA to corporate aviation.

Corporate aviation is similar to the air carrier industry in having an excellent safety record. Data show, for example, that the accident rate for U.S. corporate aircraft (business aircraft flown by professional pilots) in 2003 — 0.028 per 100,000 flight hours — was a record low for this segment of the U.S. aviation industry.[4] The accident rate for scheduled U.S. air carriers was 0.313 per 100,000 flight hours.

CAC Chairman Edward R. Williams, vice president of general aviation services and director of flight operations for Global Aerospace, said, "While air carriers are far ahead of our community in the FOQA process, the corporate aviation community operates in a very similar environment with equal, or in some instances slightly higher, risks. To improve our already enviable safety record, this community cannot defer any longer the development of this highly productive method of revealing our own types of risks in an effort to develop individual risk-avoidance strategies.

"We believe that further risk reduction for corporate aviation will result from data recorded in flight, not from subjective responses to accidents."[5]

There are significant differences between corporate flight departments and air carriers that must be addressed in adapting FOQA for corporate aviation. One obvious difference is size. A corporate flight department typically operates a mixed fleet comprising relatively few aircraft.

"Unlike an airline that can set up a system and spread the cost over a large number of airplanes, typical corporate operators with one airplane or two airplanes might not be able to justify setting up a FOQA program on their own," said Vandel.

To establish a FOQA program, an operator must develop a system that captures digital flight data, transforms the data into an appropriate format for analysis and assists in analyzing the data and generating reports. Commercial software is available for data-processing and data-analysis, but the cost of the software likely would be prohibitive for many corporate flight departments. Moreover, the amount of data and the varieties of data that would be obtained from a mixed, small fleet of airplanes likely would not justify an in-house FOQA program.

"Few individual corporate operators can afford to purchase the rather expensive software and hardware required to implement a FOQA program," said CAC Vice Chairman Edward D. (Ted) Mendenhall, former director of operations and chief of safety at Gulfstream Aerospace.[6] "One of the major challenges is that for any individual corporate operator with a few airplanes, trying to run a FOQA program on its own just doesn't make economic sense because not enough data can be generated to provide the feedback that the operator needs."

A C-FOQA operating model developed by the CAC addresses both issues by establishing a program that many corporate operators, in effect, can share. Basically, the operators would collect data recorded in their airplanes and transmit the data to a third party (i.e., a company that specializes in FOQA-data processing) that would de-identify the data, aggregate the data and generate reports for the operators.

While an air carrier typically analyzes FOQA data to identify safety-related trends that directly affect the carrier's operations, third-party analysis of aggregate corporate-aviation data would identify trends affecting specific aircraft types, specific phases of operation (e.g., approach and landing), specific events (e.g., unstabilized approaches) and operations at specific airports.

"By using de-identified aggregate data, the same value will come to a corporate operator that comes to an airline," Vandel said. "For example, if we get a significant number of a specific type of corporate airplane involved in a collective C-FOQA program, we would be able to determine how this fleet is operated for comparison with how a specific operator's airplane is operated. The variance would provide good management information. A flight department manager might say, 'That is how I want my aircraft to be operated within our safety margins,' or the manager might want to make some changes. C-FOQA would give the manager the awareness and the ability to make that determination."

Vandel said that, as in air carrier operations, corporate aircraft operating costs also could be reduced by timely identification of problems such as improper rigging of flight-control surfaces, which leads to increased fuel costs.

Another major issue that is being addressed by the CAC is the protection of C-FOQA data from use by companies to punish employees.

"For FOQA to gain the acceptance of the business aviation community, it must be perceived solely as a program to enhance the safety of flight operations," a CAC committee report said.[7] "Should data derived from a program be available for use to justify punitive actions against pilots, many of the potential benefits of FOQA will be unattainable."

An air carrier typically addresses this issue by entering into a formal agreement with the union that represents its pilots. A letter of agreement (LOA) signed by the air carrier and by the union typically specifies that FOQA data will not be used as the basis of punitive action against pilots unless the data disclose willful misconduct or a serious violation of standard operating procedure.

"Since most business aviation operations do not have organized labor unions, a LOA between flight department management and pilot groups is not a viable option [because] human resources departments [likely] would not approve of a formal agreement with an employee group where no labor union currently exists," the CAC committee report said.

The C-FOQA operating model developed by the CAC addresses this issue by ensuring that flight department management normally would have access only to de-identified aggregate data, which would prevent the identification of individual pilots.

The operating model is based on the findings of CAC working groups that explored regulatory issues and legal issues, equipment requirements and costs, and procedures for data collection and analysis, as well as a visit by CAC representatives to a major air carrier with a FOQA program.

The demonstration program will help determine the feasibility of the operating model.

"The Foundation will function as administrator of the demonstration program," said Mendenhall, who is coordinating the C-FOQA effort. "The Foundation will have a working agreement with each operator as to what equipment and reports will be provided to them, as well as a working agreement with the third-party provider as to what data-processing and reporting services they will provide.

"The operators also will be required to agree that they will not use the data for punitive purposes."

Corporate airplanes with digital data buses that can accommodate digital flight data recorders (DFDRs) are most suitable for installation of quick-access recorders (QARs), which collect FOQA data. Several manufacturers have been installing DFDRs in corporate airplanes since the late 1990s. Installation of a QAR costs about US$20,000. Participating operators will download FOQA data from the QARs into laptop computers.

"Virtually any laptop computer that you can purchase today would be adequate," Mendenhall said. "The operators will be provided the software to enable them to transmit the data via the Internet for processing and analysis by the third-party provider. The data will be encrypted when it is sent over the Internet."

Mendenhall said that interest within the corporate aviation community recently has grown.

"This is something new to us in corporate aviation," he said. "Air carriers have conducted demonstration programs for themselves before launching FOQA programs. The C-FOQA demonstration program will show us whether this is indeed feasible and beneficial for corporate aviation."

Operators interested in participating in the C-FOQA demonstration program can contact James Burin, FSF director of technical programs, at +1 (703) 739-6700, extension 106. ■

— FSF Editorial Staff

Notes

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qualify for protections provided by the FARs. Neither a regulatory framework to mandate U.S. FOQA programs — nor any regulatory protections for pilots, air carriers or FOQA data under such a framework — exist.

"For air carriers worldwide, FOQA is the right thing to do," Stuart Matthews, FSF president and CEO, said in June 2004. "My personal viewpoint is that FAA should mandate FOQA programs but, as the Foundation long has maintained, FOQA must be allied with the protection of data. I do not advocate any change that would leave pilots and airlines open to punitive actions as a result of the use of the confidential data that FOQA programs should provide. Mandating FOQA programs would have to be done in such a way that U.S. laws or regulations are changed so that data still could not be used for punitive purposes. That is very, very difficult to achieve in some cultures — including the United States — but there are precedents in countries such as Denmark. FOQA is one of the best tools we've got to improve safety."[5]

A disadvantage of the voluntary basis of FOQA in the United States has been that relatively few air carriers have established FOQA programs at a time when universal participation would enhance aviation safety, he said.

"In the United States, it seems quite likely that a considerable number of air carriers will not establish voluntarily FOQA programs," he said. "As a result, we will not be using one of the best tools we have to get the best safety results. My other concern is that FAA is a role model for civil aviation authorities in many other countries, so that if FAA does not mandate FOQA programs, others will not mandate them. For airlines lacking FOQA programs, nothing that could be improved with FOQA data would get any better, and none of the benefits to aviation safety from FOQA could begin."

Clear guidelines also will be necessary to enable future "apple-to-apples" analyses of aggregate data from many air carriers and many nations, he said.

Air carriers that have not established FOQA programs because of liability concerns should reconsider whether the absence of a FOQA program could be construed by society as a failure to implement industry best practices, Matthews said.

"My current concern is that many smaller air carriers still are not using FOQA— either in the United States or in other countries," Matthews said. "We know that all around the world, other airlines have been using flight-data monitoring for years and have been proving its value. Data published in 1996 showed that air carriers that have used FOQA the longest also were the safest in terms of accident rates. FOQA programs have been proven to prevent accidents — with many examples in which errors in the aviation system have been revealed as a result of FOQA-data analysis, leading to corrective actions."

Understanding of FOQA Varies Among Airlines

"We have tried over the years to talk with people at a number of air carriers who still do not understand the benefits embedded within a FOQA program," said Robert H. Vandel, FSF executive vice president. "I have not met people from an air carrier with a FOQA program, however, who did not sing its praises. FOQA may not identify the precursors to all types of accidents, but it allows air carriers to define and look for measurable precursors to many types of accidents. FOQA data will show the trends — whether line operations are going the way they were designed and giving time to make changes that improve not only safety but the basic operation of an airline. This is a very powerful tool that greatly assists the industry in preventing human error."[6]

Vandel said that the historical variations among nations in choosing to establish FOQA programs involve a variety of factors.

"Air carriers have been demonstrating the benefits of FOQA in the United States for the better part of a decade, and it is time to move forward and ensure that all air carriers establish FOQA programs," Vandel said. "The deeper we drive this method down into the global aviation system, the safer the system will be. It's not only the major air carriers that need FOQA programs, but the regional air carriers as well. Smaller air carriers can find ways around the problem that one airline might not have a sufficient number of aircraft in its fleet to identify statistically significant operational trends. They should look further at how to pool their data."

Air carriers have implemented FOQA programs during global economic downturns and when fuel prices were abnormally high, Vandel said, and sometimes have realized significant cost savings as a secondary benefit.

"The leadership of every airline needs to take a fresh look at the cost of a FOQA program, which is not insignificant, but also should be realistic about what an accident would cost," Vandel said. "While turning their flight data into meaningful information is when management begins to understand FOQA. In addition to identifying when an aircraft is being operated incorrectly, the FOQA program also can tell the air carrier when aircraft are being operated properly but under policies and procedures that are not optimal. Our recommendation is that air carriers establish first a FOQA program that is fairly basic, such as by selecting one modern fleet of aircraft, analyze flight data from that fleet and later expand the FOQA program."

Some FOQA opportunities — such as sharing de-identified trend information and aggregate data among air carriers — involve complex issues.

"A compelling argument can be made for this type of sharing among air carriers — but not for sharing flight-specific data or airline-specific data," he said. "I doubt that any airline would have a problem freely sharing, at a negotiable level, high-level information about its FOQA program — the operational benefits and lessons.

"Some industry specialists believe that FAA's FOQA AC is right on target in telling air carriers not to underestimate the level of detail involved in establishing a FOQA program. The biggest impediment to more U.S. air carriers establishing FOQA programs is failure of management to truly understand what FOQA can do for them. This may require a company champion who is willing to go to senior management and explain why FOQA has become so important, the benefits and limitations, the financial package required to implement a program and the return on investment. The solution is education. If senior management understands the rationale but declines to pursue FOQA, so be it. The problem lies with those who decline while they only have a cursory understanding of FOQA."

Some Specialists Avoid Reopening Old Issues

Beliefs on whether FOQA should be made mandatory in the United States vary among safety specialists.

"For most of us who have been involved in U.S. FOQA development, now is *not* the time for mandatory FOQA," said Capt. Edmond L. Soliday, former vice president, corporate safety, quality assurance and security for United Airlines and member of the FSF Board of Governors. "A FOQA program reveals what happened, but only pilots can say what they were thinking when it happened. Without the protections currently available, we would slow down FOQA progress. Instead of a free flow of safety information from pilots who have no threat of punitive action, pilots would be thinking 'everything I do is recorded' and their cooperation would be affected by renewed concern that they might be punished unfairly by people who do not understand the data. Then a pilot begins to 'manage the disc' instead of managing the flight."[7]

Protection of FOQA data from uses other than aviation safety has been addressed by FARs applicable only to voluntary programs, he said. Therefore, mandating FOQA programs in the United States would involve reopening regulatory issues that already have been resolved.

"If FOQA programs were mandated in the United States, close behind would come FAA enforcement that would mean mandatory release of flight data by the airline to the government," Soliday said. "Without

"A FOQA program reveals what happened, but only pilots can say what they were thinking when it happened."

"Major air carriers now can look at trends from 40,000 flights at a time."

protections, the government then has an obligation to use FOQA data for enforcement, and the data also may be released for unintended uses. The only way to protect FOQA data is to ensure that the airline always 'owns' the data."

Another concern is that without protections, attorneys for plaintiffs in civil lawsuits may use the discovery process to obtain FOQA data from air carriers. In contrast, attorneys for air carriers currently can influence court decisions about release of data owned by air carriers, he said.

"If FAA were to obtain FOQA data in the future, however, there would be no airline control in narrowing the request for production of data in the discovery process," Soliday said.

Some industry specialists want to preserve the voluntary basis of U.S. FOQA programs for pragmatic reasons — chiefly because they are concerned that the rule-making process might consume another five years to 10 years to effect major changes, he said.

"Pragmatists worry that a major change would bring to a halt current FOQA programs until air carriers see what the new rule is going to say," Soliday said. "Mandating FOQA is the last alternative. It took me five years to convince United Airlines to establish its current FOQA program. Any mandated program might have to be based only on exceedance data from individual flights, for example, although major air carriers now can look at trends from 40,000 flights at a time. At the current state of technology, the price of establishing a FOQA program for an airline with 20 airplanes is very steep, but we could create consortia to deal with the cost, for example."

Laws, Regulations Provide Basis of Data Protection

Since 2001, the U.S. government has addressed nonpunitive issues and data-protection issues with three regulations, guidance to FAA's aviation safety inspectors and the FOQA AC.

These documents include FARs Part 13, *Flight Operational Quality Assurance Program; Final Rule,* effective Nov. 30, 2001; FARs Part 193, *Protection of Voluntarily Submitted Information;* FAA Order 8000.81, *Flight Operational Quality Assurance Program (FOQA),* designating FOQA information as protected from public disclosure effective April 14, 2003; and FAA orders that created and then extended until Oct. 29, 2005, the term of the FOQA Aviation Rulemaking Committee (ARC), which has assisted FAA in providing guidance material on acceptable methods of compliance with the FARs.

Two of the FARs have been influential in the development of FOQA programs by U.S. air carriers, typically in a partnership with FAA. Part 13.401, "Flight Operational Quality Assurance Program: Prohibition Against Use of Data for Enforcement Purposes," codified the enforcement protection available.

The regulation, among other provisions, says, "Except for criminal or deliberate acts, the [FAA] administrator will not use an operator's FOQA data or aggregate FOQA data in an enforcement action against that operator or its employees when such FOQA data or aggregate FOQA data is obtained from a FOQA program that is approved by the administrator." FAA does not mandate approval of an air carrier's FOQA program, except to be covered by this prohibition against use of data for enforcement purposes.

Part 193 says that certain safety information and security information submitted to FAA on a voluntary basis will not be disclosed under statutory provisions intended to encourage aircraft operators to provide information that will assist FAA in conducting its safety duties and security duties. Part 13.401 says, "FOQA data and aggregate FOQA data, if submitted in accordance with an order designating the information as protected under [FARs Part 193], will be afforded the nondisclosure protections of [Part 193]."

FOQA Advisory Circular Captures Latest Methods

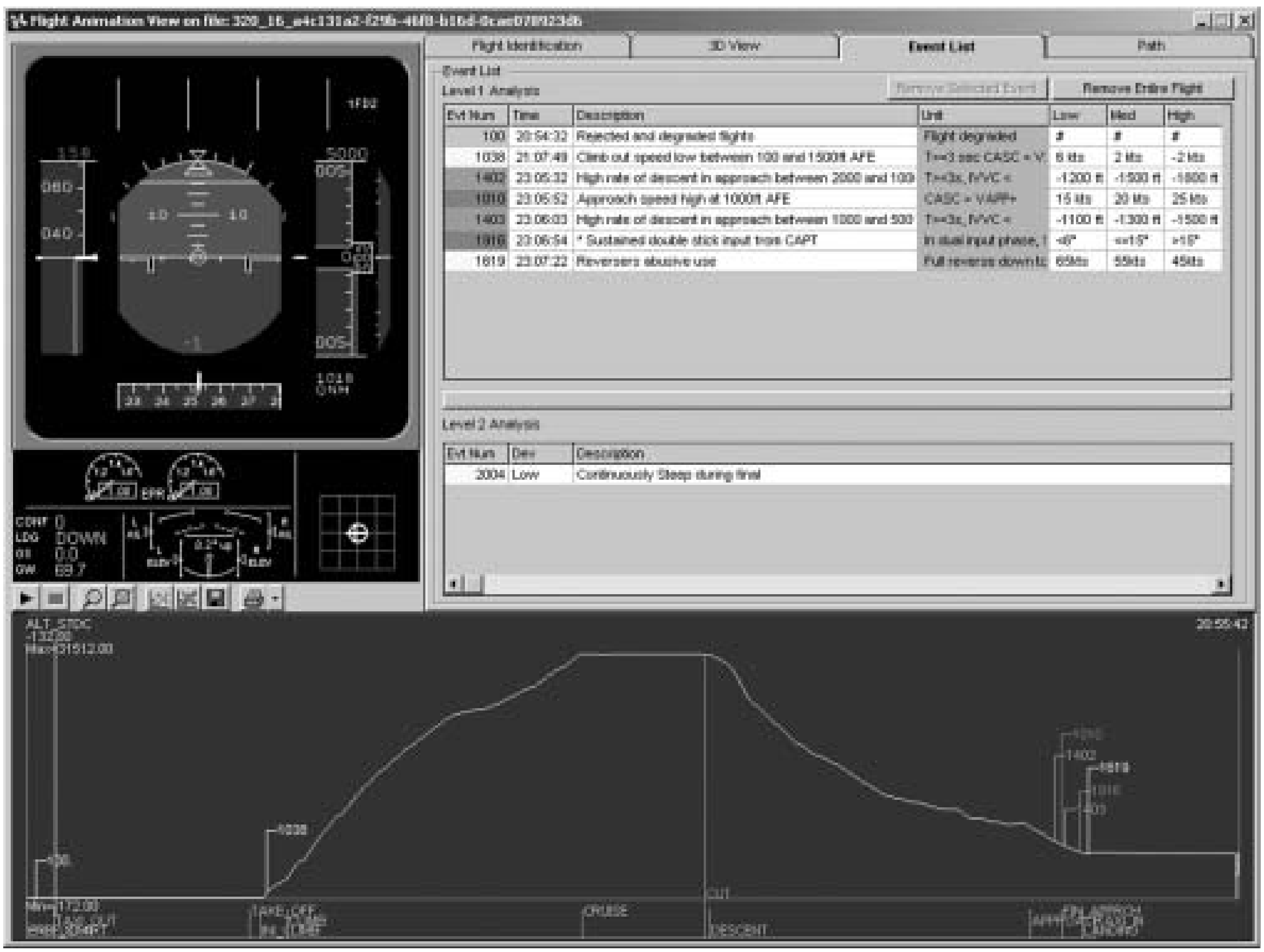
The FOQA AC incorporates lessons from the FOQA Demonstration Project of the mid-1990s, knowledge gained by FAA since 1996 from quarterly meetings with U.S. air carriers and input to an FAA draft of the AC by an AC subcommittee of the FOQA ARC, said Tom Longridge, manager of the Voluntary Safety Programs Branch, AFS-230, Air Transportation Division, FAA Flight Standards Service.[8]

As of June 2004, FAA had approved 14 FOQA programs for major air carriers and regional air carriers, including one inactive program for an air carrier involved in a merger. Another 12 air carriers have said that they have plans to establish FOQA programs; FAA does not count how many air carriers have established programs without FAA approval, Longridge said. No FAA-approved FOQA program has been discontinued permanently or has had its FAA approval withdrawn, he said.

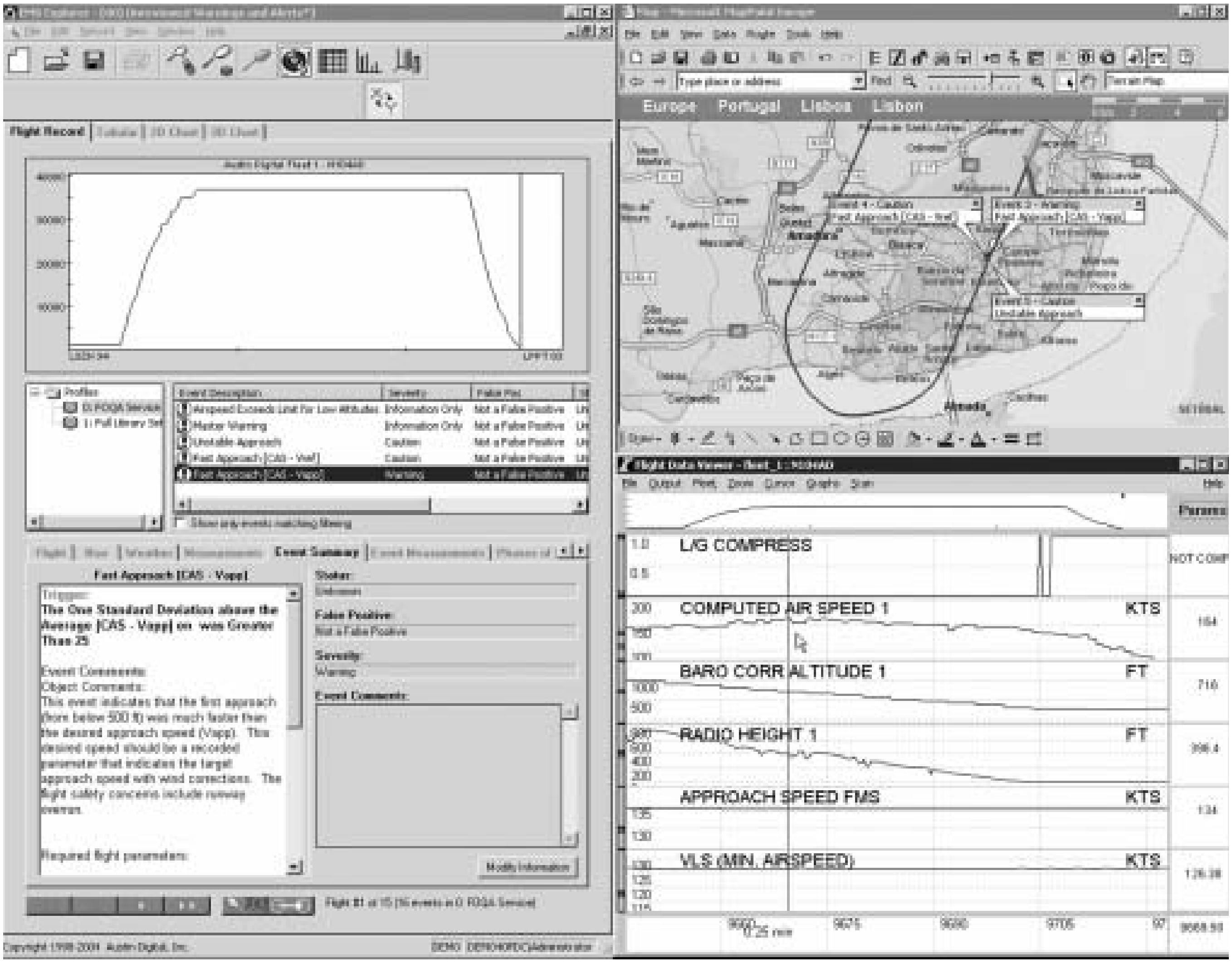
FAA also was in the process of finalizing a new FOQA chapter written for FAA Order 8400.10, *Air Transportation Operations Inspector's Handbook,* that will provide FAA personnel with guidance on approving implementation-and-operations (I and O) plans for FOQA programs and accomplishing FAA oversight activities for FAA-approved FOQA programs. FAA also began in 2004 to conduct a formal FOQA training course for its aviation safety inspectors.

FAA has made available other guidance material and information resources for U.S. air carriers with FOQA programs, and those considering FOQA programs, on a restricted-access, secure Internet site — <www.aqp-foqa.com> — which has been designed for sharing operational lessons learned and accessing information about FOQA technology. Full access is available to any airline that requests access, and controlled access is available to non-U.S. airlines, he said.

"U.S. air carriers with FOQA programs are experienced with the technology and appear



Simulated data show how animation tools enable an analyst or the flight crew to replay a sequence of flight data such as flight instrument indications, control positions and flight path. (Source: Teledyne Controls)



Simulated data from a single flight are correlated in time with the corresponding navigation view and displays of selected parameters for analysis.
(Source: Austin Digital)

so far to have been able to afford the resources required to internally operate a FOQA program — to purchase hardware and software, pay staff, perform ongoing data-analysis functions and provide for appropriate internal distribution of the information," Longridge said. "If airlines were willing to let FOQA data leave their property, they could retrieve raw data directly from a QAR, or the mandatory digital flight data recorder, and send it to a vendor for processing and analysis, thereby reducing the overhead cost of a FOQA program. This method seems to be working well for some non-U.S. airlines and might provide an affordable means worth exploring to enable smaller U.S. operators to participate in the program. To my knowledge, however, no U.S. operators with approved FOQA programs routinely are operating their programs on that basis at present."

FOQA is most effective when the company has bought into the system-safety concept from its top management down through the organization, he said.

"FOQA information is then more likely to be integrated with other sources of safety information within the company, and to garner management support when the results appear to indicate that a proactive information strategy of some sort, such as changes in company operating practices, is warranted," Longridge said. "There appears to be some evidence that the establishment of a FOQA program can positively impact the development of a safety culture within an airline over a period of time."

Most U.S. operators that have an approved FOQA program also have voluntarily established one or more other related safety programs, such as the aviation safety action program (ASAP), the advanced qualification program (AQP) and the internal evaluation program, he said. (An ASAP encourages air carrier employees to disclose information and to identify possible violations of FARs without fear of punitive enforcement sanctions when the disclosures do not involve deliberate misconduct, substantial disregard for safety and security, criminal conduct or conduct that demonstrates or raises an absence of qualifications.)

The FOQA AC recommends that air carriers considering a FOQA program conduct a user-needs study involving all airline departments. Learning who needs what information and how analysis can be used by various departments within the company is an educational exercise that can benefit overall operations, and is an important early step in planning for a FOQA program, he said.

"FOQA is a major investment, and although FAA does not endorse any product or service, we try to help air carriers to determine what questions to ask before making purchase decisions," Longridge said. "We also encourage visits to other air carriers to learn from their experience."

FAA is working through the FOQA ARC and other avenues to encourage the use of aggregate FOQA data for "superordinate aggregation" (i.e., a level of trend analysis involving multiple de-identified U.S. air carriers).

"Air carriers are deriving safety benefits and economic benefits from FOQA, and they have agreed in principle that it is in our mutual interest to come up with a means of aggregating de-identified FOQA data across all participating airlines so that adverse safety issues at a national level can be better identified and collaboratively addressed," Longridge said.

U.S. air carriers have had a significant influence on vendors' development of user-friendly, flexible and capable software to analyze and review FOQA data, he said. They particularly have been influential in encouraging vendors to provide air carriers with internal capability to make changes to analysis software, such as setting event definitions and trigger limits. In contrast to earlier FOQA-analysis software that was limited to identifying exceedances and collecting routine operational measurements, some current software enables air carriers to view entire distributions of parameters and to monitor changes in distribution characteristics over time, he said.

"At the same time, the ratio of analysts required per number of airplanes in the fleet has improved due to software efficiency, so that one analyst can analyze the flight data from many more airplanes than was possible with the software tools of a decade ago," Longridge said.

FAA Plans AC Updates About Aggregate Data

FAA's FOQA AC represents a significant advance among long-term efforts to implement FOQA in the United States, but a significant amount of work on AC revisions remains to be done, said John O'Brien, director of engineering and air safety for the Air Line Pilots Association International (ALPA), a member of FAA's FOQA ARC and a member of the FSF Board of Governors.[9]

"The AC provides a means to obtain FAA approval for an airline's FOQA program," O'Brien said. "The AC also provides a clear understanding of the intent of the FOQA regulation, and a road map for developing FOQA programs."

Joint projects of FAA's FOQA ARC and ASAP ARC are under way through a subcommittee on collection, analysis and dissemination of aggregate FOQA data.

"As this project progresses, ARC members anticipate that FAA will make administrative adjustments to this AC," O'Brien said. A revised AC would describe aggregate-data analysis and aggregate-data-exchange processes so that air carriers have guidance on how to provide de-identified aggregate data to FAA as required by the FOQA regulation; these processes then would become an integral part of an airline's FOQA program, he said.

"One analyst can analyze the flight data from many more airplanes than was possible with the software tools of a decade ago."

A primary objective is to make aggregate data accessible to FAA,

"Until FOQA reaches a greater level of maturity, it would be premature to mandate any kind of program."

which is required by the FOQA regulation, he said. This process also will make aggregate data available to air carriers other than the source of the data, which is integral to safety-oversight objectives of the FOQA regulation, he said.

Protection of flight data in FAA-approved FOQA programs has been incorporated into current law and regulations on a voluntary basis and does not exist apart from that basis. "U.S. air carriers can operate a FOQA program without FAA approval and regulatory protections, but that would be very impractical; we would not tell any ALPA pilot group to go down that road," he said.

O'Brien said that he opposes mandatory FOQA programs in the United States for the following reasons:

- Establishing a new regulatory basis for FOQA programs would require a new cost-benefit analysis, but FAA requirements typically set minimum standards rather than requiring the most advanced technology and software. "Rather than each airline's FOQA program being the best it could be, FAA would have to specify a [minimum] FOQA program that every airline could comply with on a cost basis";

- The relative financial condition of some air carriers enables them to invest more than others in a FOQA program, but if there were a new rule for a mandatory program, some air carriers might not invest enough to take advantage of FOQA advances; and,

- Private-industry competition and free-market concepts underlying FOQA development in the United States have been considered positive factors that rapidly generated practical applications, the resources required for FOQA advancement and economic benefits in addition to safety benefits.

"FAA's growing expertise in FOQA enables effective participation, but I do not believe this expertise enables the government to determine when the FOQA concept is mature enough to consider mandatory FOQA programs," O'Brien said. "The FOQA AC instead should be updated periodically to recognize the latest improvements. This is similar to the concept that FAA has for regulatory oversight and development-certification criteria for airplanes and associated systems."

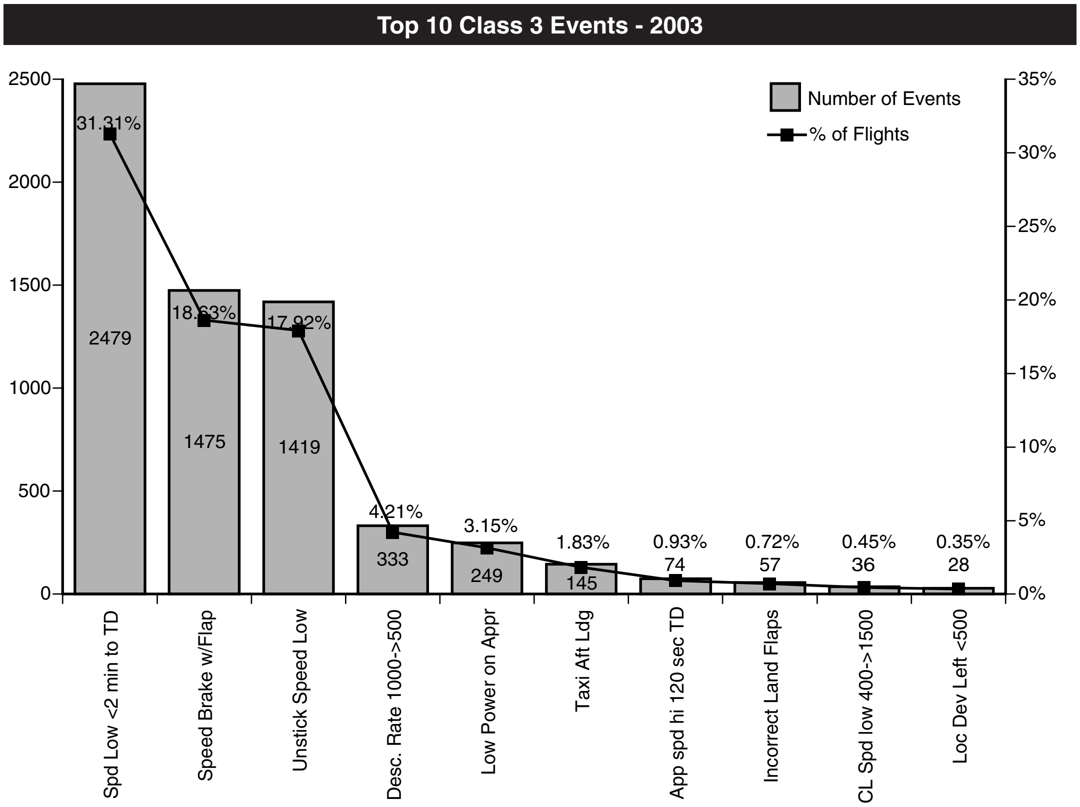
The best course of action for the time being is to maintain voluntary FOQA programs in the United States because the FOQA concept is still evolving to a significant degree, O'Brien said.

"Maturity and cost are the two main reasons for ALPA's position," he said. "We cannot describe yet what is the best FOQA program. Until FOQA reaches a greater level of maturity, it would be premature to mandate any kind of program. Mandating FOQA programs is not necessary now and may never be necessary if appropriate aggregate data-exchange methodologies are developed and implemented."

ICAO's amendment to Annex 6 regarding flight-data monitoring reflects an international perspective with roots that predate FOQA implementation in the United States, O'Brien said.

"The United States had a significant voice in the discussion of this ICAO amendment in the late 1990s," he said. "Some specialists interpret this standard and recommended practice as meaning that FOQA programs should be mandated by civil aviation authorities — I see the method of compliance as being up to individual ICAO contracting states. The FARs could be considered to show the United States to be in compliance with the standard in one sense because the regulatory provisions that provide protection of an airline's data require FAA approval of the airline's FOQA program."

"The best method is to encourage as much voluntary participation as possible," O'Brien said. "FOQA-program implementations are going very well in the United States. Although they have not matured to where an air carrier can obtain an 'off-the-shelf' program, the concept is still evolving." An event-driven FOQA program was envisioned initially, but two or three U.S. air carriers have advanced well beyond that level. FAA's encouragement has enticed more air carriers to embrace the FOQA concept, and smaller U.S. air



Event Short Name	Number of Events	% of Flights	Avg Time Exposure	Avg Max Value
Spd Low <2 min to TD	2379	31.31 %	32 sec	119
Speed Brake w/Flap	1475	18.63 %	28 sec	69
Unstick Speed Low	1419	17.92 %	141 sec	40
Desc. Rate 1000–>500	333	4.21 %	10 sec	-1803
Low Power on Appr	249	3.15 %	17 sec	277
Taxi Aft Ldg	146	1.83 %	42 sec	114
App Spd hi 120 sec TD	74	0.93 %	80 sec	261
Incorrect Land Flaps	57	0.72 %	1 sec	2
CL Spd low 400->1500	36	0.45 %	7 sec	135
Loc Dev Left <500	28	0.35 %	11 sec	2

	Event Count	Event %
Average	179.31	2.26%
Standard Dev	517.80	6.54%
Standard DevP	510.55	6.45%

Simulated statistical reports show one of the various methods of reviewing categories of events within a flight operational quality assurance program.

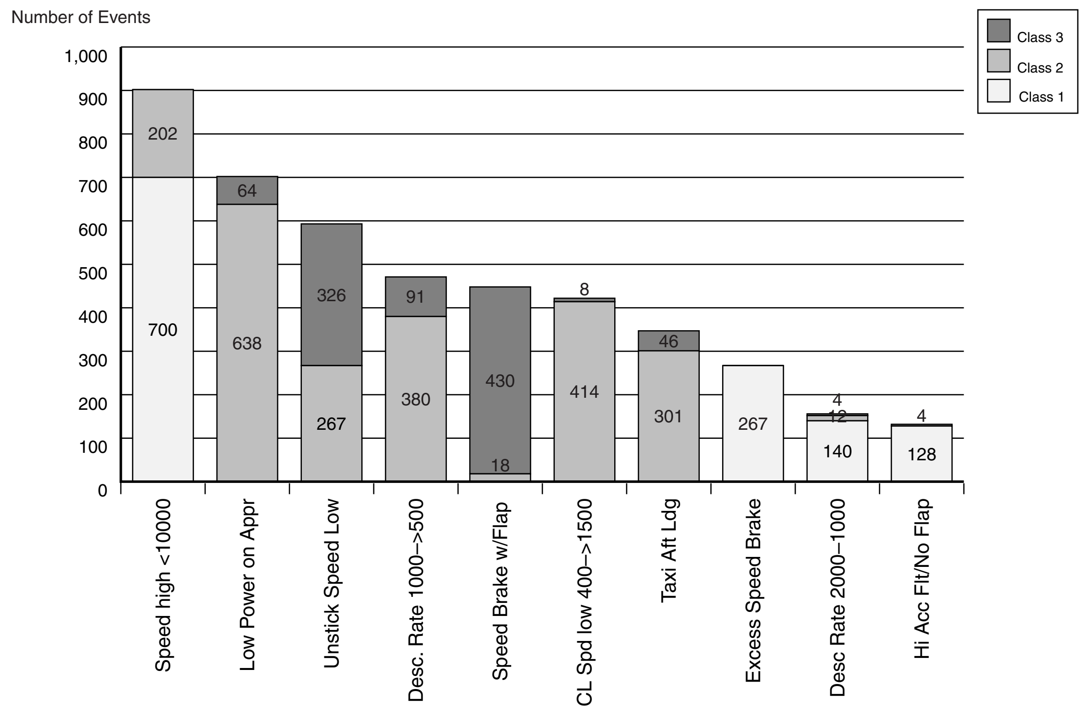
(Source: Sagem Avionics)

carriers that cannot do extensive internal FOQA development have been implementing FOQA programs, he said.

"We are not yet at the point, however, where aggregate FOQA data are flowing into FAA for routine utilization in safety oversight," he said. "FAA has found new issues to address and is involved in several safety initiatives because of safety-data analysis. We are getting closer — perhaps within a year to 18 months — to having a specific process for collection and dissemination of aggregate FOQA data."

FOQA programs no longer can be considered in isolation from safety-management systems, however.

Top 10 Events per Severity Class



Number of Events

Events	Class 1	Class 2	Class 3	*Total*	*% Total*
Speed high <10000	700	202		*902*	*20.32 %*
Low Power on Appr		638	64	*702*	*15.81 %*
Unstick Speed Low		267	326	*593*	*13.36 %*
Desc. Rate 1000–>500		380	91	*471*	*10.61 %*
Speed Brake w/Flap		18	430	*448*	*10.09 %*
CL Spd low 400–>1500		414	8	*422*	*9.50 %*
Taxi Aft Ldg		301	46	*347*	*7.82 %*
Excess Speed Brake	267			*267*	*6.01 %*
Desc Rate 2000–1000	140	12	4	*156*	*3.51 %*
Hi Acc Flt/No Flap	128		4	*132*	*2.97 %*
Total	*1235*	*2232*	*973*	*4440*	

Analyzed / Realized Flights Ratio	10.13 %

Simulated statistical reports show other methods of reviewing categories of events within a flight operational quality assurance program.

(Source: Sagem Avionics)

"I see possibilities far beyond the use of aggregate FOQA data; some are reflected in the similarities and differences of ASAP compared with FOQA," O'Brien said. "In some areas, ASAP programs are more advanced administratively than FOQA programs. For example, an FAA representative participates directly in ASAP analysis and in the decisions on corrective actions to be taken. Sensitive issues of protection of information also have been covered by criteria in the ASAP AC. The joint subcommittee of the FOQA ARC and the ASAP ARC has found that a combination of ASAP data and FOQA data provides a means to improve analysis of safety issues. In the future, other programs will be added to a total-systems method of mining all safety databases to take corrective actions.

"This total-systems method to get a complete operational picture goes far beyond FOQA data. Only by analyzing multiple sources will FAA be able to determine where to commit scarce resources in a creditable manner. Within three years to five years, we should be able to bring additional data to combine with FOQA data and ASAP data in a meaningful manner."

In the United States, pilots function as integral parts of FOQA data teams at every air carrier where pilots are represented by ALPA.

"ALPA pilots work with company managers to conduct the FOQA data analyses; it is a joint effort to decide what issues are pursued," O'Brien said. "They also may recommend issues to be examined within the processes available, but in practice, there hardly ever has been an issue that one group saw as significant and the other group did not."

FAA, U.S. air carriers with FOQA programs and the joint committee have had the opportunity to look at some issues that only could be identified through multi-airline, FOQA–ASAP data analysis, he said.

"For example, some apparent airspace hot spots — locations where an unusually high number of TCAS [traffic-alert and collision avoidance system] alerts and TCAS RAs [resolution advisories] occurred — were identified through analysis of FOQA data from several airlines," O'Brien said.

"There is a persistent misconception that pilot unions are not enthusiastic about FOQA, but we are ready to move forward," he said. "ALPA works through the ARCs, industry working groups and meetings to push the FOQA concept at every opportunity. For example, we sent letters to master executive councils of all of the ALPA pilot groups involved in the previously mentioned TCAS RA analysis. The letters stated ALPA's support for the ability of a third-party vendor to access, collect and merge data from several air carriers. Normally, a company cannot release any FOQA data without the consent of the pilot group and pilots cannot release any data without the consent of the company. We helped pilots put together a side letter of agreement for this exchange of data, and we encouraged the analytical process."

ALPA's position is that the FARs and the AC currently in place have addressed the key impediments to U.S. FOQA implementation to the degree currently practical, he said.

"The challenges of data protection from possible punitive use by the employer or by FAA have been resolved," O'Brien said. "Protection of FOQA data in the courts has not been achieved, but this probably never will be achieved to a degree that would make comfortable pilots and air carriers. Developments in this area have been positive, however, and we can accept what protective measures we have. The challenge is to maintain the data protection that we have achieved and to prevent any misuse of the data."

"There is a persistent misconception that pilot unions are not enthusiastic about FOQA …"

ALPA has not been aware of any legal challenges to the regulations on data protection — either from requests under the U.S. Freedom of Information Act (FOIA) or from civil discovery in lawsuits, he said. FOIA generally provides that any U.S. citizen or foreign national U.S. resident has a right of access, enforceable in court, to "agency records" (such as letters, reports, photographs, audio recordings and digital data) from the executive branch of the federal government — including FAA — except to the extent that these records (or a portion of these records) are protected from disclosure by one of nine exemptions. One exemption is for information specifically exempted from disclosure by other federal statutes; FOQA data, for example, are covered by a federal law and related FARs that provide protection of voluntarily submitted information. Local and state governments, as well as Congress and the federal courts, are not covered by FOIA.[10]

"What could play out in the future, however, is a major accident in which all bets are off [i.e., regulatory protections would not apply] in use of FOQA data for the investigation," he said. "The solution is not to retain identifiable FOQA data — to keep instead only de-identified aggregate data and trend information. An airline that can show corrective actions from its FOQA program should not be concerned about that information being discovered."

ALPA also has urged FAA to develop further incentives to encourage establishment of FOQA programs by more air carriers, he said.

"For example, we certainly see potential benefits of applying the FOQA data to validate changes in operating procedures or in the introduction of a new ATC infrastructure," O'Brien said.

Non-U.S. Airline Experience Yields Valuable Lessons

Non-U.S. air carriers with significant FOQA experience have offered the following advice to others in various FSF seminar papers and articles:

- Air carriers will not benefit simply by purchasing FOQA technology; they must conduct meaningful analysis, followed by wisely applied decision-making;
- Over time, an airline's FOQA program may evolve into various types of analysis, such as automatic analysis, which compares how the aircraft is operated to a predefined model, based on the manufacturer's manual and the operator's SOPs; event analysis, which searches the flight data for excursions from a safe flight envelope; and measurement analysis, which captures values for various parameters at the same point on each flight and plots a standard distribution for each;
- Some FOQA programs enable continuous auditing of pilot performance by identifying noncompliance with SOPs; inadequate SOPs and inadequate published procedures; ineffective training and briefing; inadequate handling or command skills; fuel inefficiencies; and environmental infringements; and,
- For serious events identified by FOQA, some air carriers have archived a subset of de-identified flight data to enable replay-simulation of the flight deck instruments and graphic representation of flight path. Detailed feedback has been sent to the crew (via the pilot union) in the form of a few minutes of relevant data and an animation program for replay on a personal computer.

Capt. Bertrand de Courville of Air France said that routinely monitoring flight data helps to make understandable aircraft events. (FSF Photo)

Speakers at 2004 Seminar Cite Benefits of FOQA

At an international aviation safety seminar in São Paulo, Brazil, in May 2004, safety specialists from air carriers shared FOQA-related experiences, including the following observations:

- Kwok Chan, Ph.D., head of safety and accident investigations for Airbus, said that software to support effective FOQA programs currently is widely available from various vendors, and he said that postflight data-analysis capabilities have been incorporated into the design of the Airbus A380's onboard information server. "Upon landing, pilots can have instant feedback — including a visual replay and analysis of the flight — from this system," he said. "The crew also will be able to add its own comments at that time to the data that will be downloaded for the analysts;"[11]
- Capt. Bertrand de Courville, an Airbus A340/A330 captain and head of safety at Air France (now part of the KLM/Air France Group), said that FOQA will become mandatory for European air carriers through Joint Aviation Requirements—Operations (JAR–OPS) in January 2005. In early 2004, Air France celebrated with its pilots the 30th anniversary of a 1974 agreement with pilot unions on uses of FOQA data. The first event detected in 1974 was an unstabilized circle-to-land approach; until a trusted-third-party system was adopted in 1987 to maintain confidentiality of identifiable flight data, however, Air France policy was not to discuss with crews why events had occurred. "The events that we detect today are totally different, but I strongly believe that flight-data monitoring has contributed directly to safety improvements," de Courville said. "Because of the long history,

there is a high level of trust and nothing really changed for French pilots or airlines when FOQA became mandatory in 2000 — the system works the same. Flight-data monitoring induces self-discipline in airline crews, and it has been a great advantage to be able to identify crews for confidential review of selected flights. In Air France and in other places in Europe, through some combination of new tools and safety methods, we should not be operating in a parallel way with civil aviation authorities but with some kind of cooperation. The question in the future will be how civil aviation authorities behave in the context of mandatory flight-data monitoring all over Europe — they must be careful because this program already works, and acceptance of changes may take four years to 10 years." France was among the first countries to mandate flight-data monitoring.[12]

- In Colombia, while air carriers continue to work with the civil aviation authority on nonpunitive regulatory methods with data protection, Avianca Airlines currently analyzes data from DFDRs and expects to monitor data from its entire fleet of Boeing 757 (B-757) and B-767 aircraft by the end of 2004. The program is being integrated with line operations safety audits (LOSA), said Capt. René Márquez, director of safety.[13]

- Capt. Manin K. Al-Said, head of flight safety and quality assurance for Gulf Air, said that flight-data monitoring currently is conducted for 70 percent of flights, and the percentage is expected to increase as the result of a pending change to wireless downloading of flight data. FOQA data are part of a feedback loop to the airline's advanced qualification program of pilot training, he said;[14] and,

- Eduardo Chacin, manager, operations and infrastructure, Latin America and Caribbean, for the International Air Transport Association (IATA) said, "Without data for the flight — yours is just another opinion." IATA's new safety-intelligence system (iSAFA) incorporates FOQA, for example, Chacin said.[15]

- Cobus Toerien, manager, flight safety, of South African Airways, said that the company has structured its FOQA activities to be entirely separate from the flight safety department;[16]

- TAM Brazilian Airlines established a FOQA program in 2002 as part of a company-wide safety-monitoring system and conducted a FOQA seminar in September 2003 for its pilots. As of May 2004, the program monitored flight data for 98 percent of Airbus A319/320 flights, 98 percent of A330 flights and 35 percent of Fokker F100 flights. Exceedances of flight parameters related to SOPs have been classified in three exceedance levels, with level 3 events requiring review of the event by the captain with designated company pilots who maintain confidentiality. Level 3 events have been reduced by 82 percent under the program, and the airline has saved about 25 percent on insurance premiums, said Capt. Marco A. de M. Rocha Rocky, flight safety officer and an A330 captain. Company policy on the confidential and restricted use of identifiable flight data is detailed in an agreement with pilots and a policy letter from the company president; procedures and authorized uses of FOQA data also are explained in a brochure for crewmembers. Negotiations between TAM representatives, other air carriers and the Brazilian Aeronautical Accident Prevention and Investigation Center (CENIPA) were expected to be completed in 2004, generating regulatory protections for Brazilian air carriers and pilots while recognizing FOQA programs as an international best practice.

Capt. Geraldo C. de Meneses Harley of TAM Brazilian Airlines conducts flight-data validation and safety analysis in the company's flight operational quality assurance program. (FSF Photo)

Automatic analysis of flight data from a single aircraft, downloaded at 15-day intervals, takes about five minutes and manual review of the flight data requires about half a day, said Capt. Geraldo C. de Meneses Harley, who flies the Airbus A320 and is one of four designated pilots who conduct FOQA data analysis six days to eight days per month. "FOQA has become the friend of the TAM pilot," Harley said. "For example, in one runway-overrun incident, flight-data analysis

"FOQA has become the friend of the TAM pilot."

showed that the crew had done everything correctly according to SOPs. Other FOQA-based research showed that one standard terminal arrival procedure in Brazil required crews to descend 6,000 feet in five minutes, so the civil aviation authority changed the approach. Because other FOQA data showed TCAS events related to helicopter operations during short final at one airport, a new ATC tower frequency and helicopter-operating corridor were created." TAM initially involved its pilots as a group in identifying FOQA parameters and limits, but explicitly requires crews to comply with SOPs and manuals for flight operations, he said;[17]

- Capt. António José dos Santos Gomes, an Airbus A319/A320/A321 captain and flight safety manager of TAP Air Portugal, said that the airline's FOQA program evolved from laborious manual processes of data analysis in 1962 to computerized processes in 1985. Although still relatively labor-intensive, FOQA is considered indispensable in risk management, he said. The TAP FOQA program monitors data for all 157 daily flights, Gomes said. "Although the system has become outdated, it still gives us good information for 90 percent of flights," he said; and,[18]

- Capt. Jason Holt, an Airbus A340 captain and manager of safety services for Virgin Atlantic Airways, said that the company uses FOQA data within its safety management system and has arranged to lease de-identified FOQA data to international regulators to assist in their oversight activities.[19]

FOQA Successes Show Range of Possible Uses

The following examples of FOQA successes have been cited in FSF publications and speeches in recent years:

- During takeoff, the pilots of one air carrier were over-rotating a new airplane model — raising the nose too high and, thus, moving the tail of the airplane too close to the ground. Revised training and warnings rectified the problem before a tail strike occurred;

- Unexplained stick-shaker (stall-warning) actuations have been resolved;

- FOQA data have been used to prove that aircraft problems were induced by runway-surface conditions;

- FOQA programs have measured excessive sideloads on the aircraft when ATC instructed the crew to take a high-speed turnoff from the runway and have identified reasons for excessive tire wear resulting from ATC instructions to land and hold short of an intersecting runway;

- FOQA data have been used to back up air carriers' warranty claims to airframe, engine and equipment manufacturers and to confirm airline performance to specifications under cargo-related contracts;

- A FOQA program resolved an excessive number of unstabilized approaches at a hub airport by showing a reason to redesign an instrument approach;

- Increasing minimum vectoring altitudes in mountainous terrain prevented GPWS warnings while aircraft were being radar-vectored to an airport; and,

- Pilot training was improved to conduct timely and correct GPWS escape maneuvers.

Time Line Shows FOQA Promotion Efforts

In 1989, the Foundation presented a workshop in Taiwan, China, that highlighted the benefits of FOQA programs, and began to encourage wider adoption of FOQA. In 1990, an FSF workshop focused on the development of FOQA programs in the United States; more than 100 participants from 17 nations attended the meeting in Washington, D.C., where FOQA users among the Foundation's international membership discussed the benefits of their programs. This meeting was a catalyst for U.S. FOQA implementation.

In 1992, the FSF Icarus Committee met for the first time and issued 10 recommendations for action. One said that the Foundation should encourage countries to provide legal protection of identities in FOQA programs, to encourage nonpunitive discussions of incidents and to promote the use of FOQA programs among air carriers worldwide.

The Icarus Committee said that FOQA enables air carriers to "feel the pulse" of line operations by analyzing a stream of information, positioning management to take decisions based on data, not on speculation, anecdotal events or opinions. (The FSF Icarus Committee was created to explore ways to reduce aviation accidents resulting from human factors. The committee comprises a small group of recognized international aviation specialists who have extensive experience in human factors. The size and the informal makeup of the committee facilitate objective and open deliberation.)

Under a 1991 contract with FAA, the Foundation completed a comprehensive study of FOQA and published its findings in *Air Carrier Voluntary Flight Operational Quality Assurance Program,* a report that became the blueprint for initiating FOQA programs in the United States. The Foundation recommended that FAA promote voluntary FOQA programs by instituting a demonstration program in partnership with industry.

When FSF task forces studied controlled flight into terrain (CFIT) and approach-and-landing accidents during the mid-1990s, the potential value of FOQA programs was reiterated. Specifically, these studies found that "collection and analysis of in-flight parameters (e.g., [FOQA] programs) identify performance trends that can be used to improve approach-and-landing safety." The recommendations also said that air carriers should install QARs and implement FOQA programs to detect reasons for unstable approaches; share knowledge based on FOQA data with operators, airport authorities and air traffic services; publicize widely examples of FOQA benefits (safety improvements and cost reductions); and that a process should be developed to bring FOQA and information-sharing partnerships to regional air carriers and business aviation. (CFIT occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew.)

Scientists working for the U.S. National Aeronautics and Space Administration (NASA) said in 1999 that the industry should explore the potential of using FOQA data as a source of nonpunitive feedback about the effectiveness of glass-cockpit training.

Matthews said that the Foundation also continues to work to counteract criminalization of accident investigations and civil lawsuits that could lead to judicial orders for disclosure of FOQA data.

Flight International magazine in 2002 cited the Foundation's work to encourage wider use of FOQA as one of the global safety-improvement milestones of the 1990s.

Former FSF President Sees Uneven Growth in FOQA

John H. (Jack) Enders, an aviation consultant, former president of the Foundation and co-author of the FSF FOQA study for FAA, said that by the early 1990s, non-U.S. air carriers were using FOQA programs "to analyze the safety quality of their operations and to detect subtle or insidious trends that can creep into daily operations." The United States became the Foundation's target of efforts to expand FOQA programs, but "the threat of liability or punitive actions against both companies and pilots has hampered beneficial safety-information transfer," he said.[20]

FOQA enables air carriers to "feel the pulse" of line operations … based on data, not on speculation, anecdotal events or opinions.

In June 2004, Enders said that based on air carrier safety assessments, he has observed variations in how they interpret FOQA programs.

"If the potential of FOQA is not being realized, underlying causes may be the safety culture or the resources," he said. "Some

Photorealistic animations based on de-identified flight data enable the visualization/study of events by air carrier pilots and safety professionals. (Source: CEFA Aviation)

air carriers see FOQA as a disciplinary tool while others are using FOQA programs in the spirit intended, with nonpunitive provisions."

Within the aviation industry, some senior managers continue to be resistant to the concept of nonpunitive safety programs despite requests for such programs from their flight operations department, he said.

"FOQA programs in the United States have developed in an uneven way — some air carriers have not understood the concept," Enders said. "Financial stresses also certainly are having a chilling effect on some air carriers doing all that they could do with their FOQA programs. An important question in a thinly staffed department is how these stresses might affect their ability to conduct effective trending and analytical work."

A generational change of airline personnel has occurred in the years elapsed since FOQA programs first were established in the United States.

"I am not sure how successfully the original vision has survived into the present," Enders said. "Sometimes when I move outside of the flight operations group of either a U.S. airline or a non-U.S. airline and into the administrative level, there is resistance about structuring a viable FOQA program, so challenges remain to a full realization of the FOQA concept."

Although some air carriers have such issues, they occur against a backdrop of positive technological advantages for establishing FOQA programs.

"These advantages mainly are the ability to quickly process massive amounts of data; the growing body of analytical knowledge for coding data to make it useful for trending and identifying problems; and the possibility of future links between integrated databases of the government and the airline's internal data for safety-analysis purposes," he said. "But innovation requires vision — especially in tight-budget times."

An FSF working group concluded in 1992 that a civil aviation authority's comprehensive policy on compliance and enforcement should reduce air carrier concerns and flight-crew concerns about use of FOQA data for other than safety purposes and operational enhancement purposes, and that all flight data that would identify any airline, flight or crewmember should be destroyed as soon as possible.

Based on the report's conclusions, the Foundation recommended that FAA encourage voluntary FOQA implementation by U.S. operators and envisioned that the industry would be able to develop common FOQA standards and specifications to enable global exchange of safety information and the development of research databases. FOQA in the United States has been voluntary since its inception, and current regulations and guidance material are based on the assumption that pilots and air carriers support establishing FOQA programs not only for safety reasons but in the context of a nonpunitive policy and protection of flight data.

By the end of the 1990s, the consensus of air carriers with FOQA programs was that this tool had the proven potential to save long-term costs for air carriers by reducing the risk of a major accident, improving operating standards, identifying external factors that influence the operation and improving engineering–monitoring programs.

In 2000, Enders and co-authors of another report said, "FOQA, though acknowledged as beneficial by a majority of U.S. operators, has fallen short of its full potential as a comprehensive, integrated and universal system. A major reason for this lies within the societal and legal structure of the United States. … In many cases, there also may be a substantial lack of appreciation of the significance of precursor trends that could be identified from shared data. Effective FAA, manufacturer and airline operator educational programs may develop the level of understanding necessary for aggressive identification of precursors. … Data sharing would provide each operator a means of evaluating its own operation and continuing airworthiness programs against an industrywide norm that would not be attributable to specific competitors."[21] ■

Notes

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10. Requesting "agency records" under the U.S. Freedom of Information Act is reasonably simple. Nevertheless, under the law's exemptions, a federal agency can elect to withhold the requested information. The withholding, for example, might be outright or in the form of a document with obliterated text. Requesters can file administrative appeals for the withheld information and file a lawsuit. A newspaper reporter might cite the public's right to know versus privacy, along with appropriate legal precedents, all aimed at persuading a government employee to waive the exemption(s). Many court cases have been generated by federal agencies' decisions to withhold information. Cases have been won and cases have

been lost, so court action does not guarantee disclosure.

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U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

Subject: FLIGHT OPERATIONAL QUALITY ASSURANCE | **Date: 4/12/04** | **Initiated By: AFS-230** | **AC No: 120-82** | **Change:**

1. PURPOSE. This advisory circular (AC) provides guidance on one means, but not necessarily the only means, of developing, implementing, and operating a voluntary Flight Operational Quality Assurance (FOQA) program that is acceptable to the Federal Aviation Administration (FAA).

a. FOQA is a voluntary safety program that is designed to make commercial aviation safer by allowing commercial airlines and pilots to share de-identified aggregate information with the FAA so that the FAA can monitor national trends in aircraft operations and target its resources to address operational risk issues (e.g., flight operations, air traffic control (ATC), airports). The fundamental objective of this new FAA/pilot/carrier partnership is to allow all three parties to identify and reduce or eliminate safety risks, as well as minimize deviations from the regulations. To achieve this objective and obtain valuable safety information, the airlines, pilots, and the FAA are voluntarily agreeing to participate in this program so that all three organizations can achieve a mutual goal of making air travel safer.

b. A cornerstone of this new program is the understanding that aggregate data that is provided to the FAA will be kept confidential and the identity of reporting pilots or airlines will remain anonymous as allowed by law. Information submitted to the FAA pursuant to this program will be protected as "voluntarily submitted safety related data" under Title 14 of the Code of Federal Regulations (14 CFR) part 193.

(1) In general, aggregate FOQA data provided to the FAA under 14 CFR part 13, section 13.401 should be stripped of information that could identify the submitting airline prior to leaving the airline premises and, regardless of submission venue, should include the following statement:

WARNING: This FOQA information is protected from disclosure under 49 U.S.C. 40123 and part 193. It may be released only with the written permission of the Federal Aviation Administration Associate Administrator for Regulation and Certification.

(2) However, if an airline voluntarily elects to provide the FAA with aggregate FOQA data that includes airline identifying information, then it should include an additional statement that it is the proprietary and confidential property of [Airline Name].

c. As defined in this AC, operator FOQA programs include provisions for the identification of safety issues and development and implementation of corrective actions. FOQA can provide objective safety information that is not otherwise obtainable. No aircraft operator is required to have a FOQA program. No operator that conducts a FOQA program is required to obtain FAA approval of that program. However, an aircraft operator that seeks the protection available in part 13, section 13.401 from the use by the FAA of FOQA information for enforcement purposes must obtain FAA approval of its program. For that purpose:

(1) The elements of a FOQA program are set forth by an aircraft operator in an Implementation and Operations (I&O) Plan that is submitted to the FAA for review and approval. Guidance on the appropriate content of a FOQA I&O Plan is provided in appendix A of this AC.

(2) The guidelines contained herein are based on the extensive experience of the FAA and the airline industry in developing FOQA programs and constitute a compilation of best practices. The provisions of this AC neither add nor change regulatory requirements or authorize deviations from regulatory requirements.

2. BACKGROUND. In recent years, the FAA and the air transportation industry have sought additional means for addressing safety problems and identifying potential safety hazards. Based on the experiences of foreign air carriers, the results of several FAA-sponsored studies, and input received from government/industry safety forums, the FAA has concluded that wide implementation of FOQA programs could have significant potential to reduce air carrier accident rates below current levels. A reduction in the already low U.S. airline accident rate is needed to preclude a projected growth in the number of accidents, which is expected to occur due to increased future traffic volume. The value of FOQA programs is the early identification of adverse safety trends that, if uncorrected, could lead to accidents. A key element in FOQA is the application of corrective action and follow-up to assure that unsafe conditions are effectively remediated.

3. SCOPE AND APPLICABILITY. The information contained in this AC applies primarily to air carriers that operate under part 121 or 135, but may be applicable to operators under other parts. The aircraft operator voluntarily enters into a FOQA program.

4. RELATED REGULATIONS (14 CFR).

- Part 13
- Part 119
- Part 193

5. KEY TERMS. The following key terms and phrases are defined for the purposes of FOQA to have a standard interpretation of the guidance offered in this AC. Abbreviations are listed in paragraph 11.

a. Aggregate Data. The summary statistical indices that are associated with FOQA event categories, based on an analysis of FOQA data from multiple aircraft operations.

b. Aggregation. The process that groups and mathematically combines individual data elements based on some criterion (e.g., time, geographical location, event level, aircraft type). Each aggregation is based on factors of interest to the analyst at a particular point in time.

c. Data Management Unit (DMU). A unit that performs the same data conversion functions as a Flight Data Acquisition Unit (FDAU), with the added capability to process data onboard the aircraft. Additionally, this unit has a powerful data processor designed to perform in-flight airframe/engine and flight performance monitoring and analysis. Some DMUs have ground data link and ground collision avoidance systems incorporated into the unit.

d. Data Validation. A process during which flight data are reviewed to see that they were not generated as a result of erroneous recording or damaged sensors.

e. De-identified Data. Data from which any identifying elements that could be used to associate them with a particular flight, date, or flightcrew has been removed.

f. Event. An occurrence or condition in which predetermined values of aircraft parameters are measured. Events represent the conditions to be tracked and monitored during various phases of flight and are based on the sensory data parameters available on a specific aircraft fleet.

g. Event Category. Event categories are areas of operational interests (e.g., aircraft type, phase of flight, geographical location) on which FOQA event monitoring and trend analysis is based.

h. Event Levels. The parameter limits that classify the degree of deviation from the established norm into two or more event severity categories. When assigning levels to an event, consideration is given to compliance with federal regulations, aircraft limitations, and company policies and procedures.

i. Event Set. A collection of events designed to measure all aspects of normal flight operations for a particular aircraft type at a particular air carrier. Individual events within the event set would be customized to the approved limitations for the aircraft type and in accordance with the air carrier's operational procedures. The event set for a particular fleet may be limited by the available parameters on the aircraft.

j. Event Validation. The process in which an event is determined to be a valid sample of operation outside the established norm. Even though aircraft parameter limits may have been exceeded, a valid event may not have occurred (e.g., significant localizer deviation may have occurred when an aircraft was making a sidestep approach to a parallel runway).

k. Flight Data Acquisition Unit (FDAU). A device that acquires aircraft data via a digital data bus and analog inputs and that formats the information for output to the flight data recorder in accordance with requirements of regulatory agencies. In addition to the mandatory functions, many FDAUs have a second processor and memory module that enables them to perform additional Aircraft Condition Monitoring System (ACMS) functions/reports. The FDAU can provide data and predefined reports to the cockpit printer, directly to Aircraft Communications Addressing and Reporting System (ACARS) for transmittal to the ground, or to a Quick Access Recorder (QAR) for recording/storage of raw flight data. The FDAU can also display data for the flightcrew.

l. Flight Data Recorder (FDR). A required device that records pertinent parameters and technical information about a flight. At a minimum, it records those parameters required by the governing regulatory agency, but may record a much higher number of parameters. An FDR is designed to withstand the forces of a crash so that information recorded by it may be used to reconstruct the circumstances leading up to the accident.

m. Flight Operational Quality Assurance (FOQA). A voluntary program for the routine collection and analysis of flight operational data to provide more information about, and greater insight into, the total flight operations environment. A FOQA program combines these data with other sources and operational experience to develop objective information to enhance safety, training effectiveness, operational procedures, maintenance and engineering procedures, and air traffic control (ATC) procedures.

n. FOQA Monitoring Team (FMT). A group comprised of representatives from the pilot group, if applicable, and the air carrier. This group is responsible for reviewing and analyzing flight and event data and identifying, recommending, and monitoring corrective actions.

o. FOQA Plan. An internal air carrier planning document that contains detailed information on FOQA implementation and operation and serves as the basis for the I&O Plan.

p. FOQA Steering Committee. An oversight committee formed at the beginning of FOQA program planning to provide policy guidance and vision for the FOQA effort. Membership may include a senior management person and representatives from key stakeholder departments, such as flight operations, maintenance, training, and safety. A representative from the pilot association is also typically included on this committee.

q. Gatekeeper. The FMT member who is primarily responsible for the security of identified data. The gatekeeper is the individual(s) who can link FOQA data to an individual flight or crewmember. The gatekeeper is normally a member of the pilot association.

r. Ground Data Replay and Analysis System (GDRAS). A software application designed to:

- Transform airborne-recorded data into a usable form for analysis
- Process and scan selected flight data parameters

- Compare recorded or calculated values to predetermined norms using event algorithms
- Generate reports for review

s. Implementation and Operations Plan (I&O Plan). A detailed specification of key aspects of a FOQA program to be implemented by an air carrier, including:

- A description of the operator's plan for collecting and analyzing the data
- Procedures for taking corrective action that analysis of the data indicates is necessary in the interest of safety
- Procedures for providing the FAA with de-identified aggregate FOQA information/data
- Procedures for informing the FAA as to any corrective action being undertaken

t. Logical Frame Layout (LFL). A data map that describes the format in which parameter data are transcribed to a recording device. This document details where each bit of data is stored.

u. Parameters. Measurable variables that supply information about the status of an aircraft system or subsystem, position, or operating environment. Parameters are collected by a data acquisition unit installed on the aircraft and then sent to analysis and reporting systems.

v. Phase of Flight. The standard high-level set of activities performed by pilots on all operational flights (i.e., preflight, engine start, pushback, taxi, takeoff, climb, cruise, descent, holding, approach, landing, taxi, and postflight operations).

w. Quick Access Recorder (QAR). A recording unit onboard the aircraft that stores flight-recorded data. These units are designed to provide quick and easy access to a removable medium on which flight information is recorded. QARs may also store data in solid-state memory that is accessed through a download reader. QARs have now been developed to record an expanded data frame, sometimes supporting over 2,000 parameters at much higher sample rates than the FDR. The expanded data frame greatly increases the resolution and accuracy of the ground analysis programs.

x. Routine Operational Measurement (ROM). A "snapshot" look at a selected parameter value at predefined points in time or space during every flight being analyzed by the GDRAS. ROMs provide standard statistics (e.g., minimum, maximum, average) for the specified parameter for a particular period of time or condition. Since ROMs are collected on every flight, they provide valuable trending insight into normal operations. Routine operational measurements are also useful in establishing a baseline for normal aircraft operation across a fleet.

y. Sample Rate. The number of times per second that a specific parameter value is recorded by the onboard recording system. Normally, most parameters are sampled once per second. Increasing or decreasing the sample rate will directly increase or decrease the amount of data recorded by the onboard system. The ability to change a parameter sample rate is a function of the measurement source and the onboard recording system capabilities. Varying the parameter sample rate can be useful in enhancing time critical analysis capabilities.

z. Stakeholder. Constituencies that are potential users of FOQA data and that have a stake in the program's success.

aa. Wireless Data Link (WDL). A system that allows the high-speed transfer of onboard aircraft data to ground facilities using various wireless technologies. It may also allow for upload of data to the aircraft. Sometimes referred to as Ground Data Link (GDL).

6. FOQA PROGRAM OVERVIEW.

a. FOQA Program Components. The primary components of a FOQA program include:

(1) Airborne Data Recording Systems. These systems acquire and capture the necessary in-flight information. They include specific aircraft data input sources and the equipment to record and store the collected data. Data are gathered via onboard sensors that measure significant aspects of aircraft operation. Most sensor information is carried to its eventual destination via several data buses. Data are collected by interfacing with these buses. Other airborne equipment can be used to process and analyze the collected data, display the data to pilots during flight or on the ground, and transmit data to a GDRAS.

(2) GDRASs. These systems can:

- Transform flight-recorded data into a usable format for processing and analysis
- Process the data
- Detect events and ROMs that are being monitored and tracked
- Generate various reports and visualizations to help air carrier personnel interpret events
- Process information from a variety of recorded data formats and recorder types

(3) Air/Ground Data Transfers. One of the most labor intensive and costly aspects of a FOQA program is determining and implementing the process of getting the data from the aircraft onboard recording system to the GDRAS for analysis. Operators must pay strict attention to identifying the process that meets their FOQA program needs. Items to consider are:

(a) Scheduling of the Removal of the Recording Medium. This will normally require close coordination with the operator's maintenance control and line maintenance departments. Most likely, maintenance will want to remove the medium at a scheduled overnight maintenance location so that the removal process can be included as part of a regular work package or routine. This removal time period must coincide with recording medium memory capability and meet the operator's needs for timely analysis of FOQA data as defined in the I&O Plan. Specific procedures on process for data removal will have to be defined for line maintenance personnel to permit proper data download. Sufficient spare recording medium will have to be maintained at the maintenance facilities so that the medium can be replaced back into aircraft systems after download.

(b) Forwarding of Data to the GDRAS Location. Depending on the size of the operator's route structure, the location of where the data is removed in relation to the location of the GDRAS can be great. Methods for transferring the data to the GDRAS may consist of the following:

1 **Ground-Based Transportation.** The storage medium can be mailed from the maintenance location using regular mail, company mail, or private overnight forwarding companies. If this type of process is used, a tracking system should be developed so that the recording medium removal timing and location can be verified and documentation of aircraft data retrieval can be maintained. This will prevent a loss of recording medium so that the timing of data acquisition into the GDRAS can be tracked.

2 **Electronic Transmission.** This is a remote data transmission from the aircraft maintenance location to the GDRAS by the use of download equipment or milking-type machines that interface with the aircraft or by removal of the storage media from the onboard system. This process, while more efficient, requires a larger capital outlay and requires sufficient data transmitting capability from the remote maintenance locations to the location of the GDRAS. Coordination with an operator's information services department will be needed to accomplish this. Data security issues must be considered when incorporating this process.

3 **Wireless Transmission.** This is an emerging technology that enables direct transmission of aircraft flight data to a network that interfaces with the GDRAS using wireless technology. The download is accomplished automatically, thus removing the requirements for maintenance involvement. Incorporation of this technology involves aircraft and ground-based data transfer systems to be installed. Data security issues must be considered when incorporating this process. Close coordination with an operator's engineering and information services departments will be needed.

b. FOQA Program Description.

(1) The improvement of flight safety is the driving force behind the implementation of FOQA programs. A FOQA program is used to reveal operational situations in which risk is increased in order to enable early corrective action before that risk results in an incident or accident. FOQA should interface and be coordinated with the operator's other safety programs. The FOQA program should be part of the operator's overall operational risk assessment and prevention program as described in part 119, section 119.65 and FAA guidance materials. Being proactive in discovering and addressing risk will enhance air safety.

(2) In a FOQA program, data are collected from the aircraft by using special acquisition devices, such as QARs, or directly from the FDR. Using one of several available transmission methods, data are periodically retrieved and sent to the air carrier's FOQA office for analysis. This office usually resides within the flight safety organization at the air carrier. The data are then validated and analyzed using specialized processing and analysis software, known as GDRAS, designed to convert the flight data into usable information.

NOTE: The quality and capability of a carrier's FOQA program will be directly dependent on the number of parameters available. The carrier should see that sufficient parameters are available for collection from the acquisition device or FDR (see appendix A, Example of a FOQA Implementation and Operations Plan).

(3) The GDRAS transforms the data into an appropriate format for analysis and generates reports and visualizations to assist personnel in analyzing the collected data. It extracts FOQA events from the raw digital data stream based on parameters, threshold values (e.g., descent rate in excess of 1,000 feet per minute on approach), and/or routine operational measurements that are specified by the air carrier. The analysis may focus on events that fall outside normal operating boundaries, event categories, or ROMs, as determined by the air carrier's operational standards (as well as the manufacturer's aircraft operating limitations). The FOQA FMT then reviews the events to assess their validity and potential significance. FOQA events are then marked for appropriate handling.

(4) In terms of determining the root causes of systemic problems that need correction, aggregate FOQA data have proven to be of greater value than detailed parameter data gathered during a single flight. Individual data records are typically aggregated into categories to assist the analyst in looking for trends and patterns. For example, an analysis may be conducted on the average maximum rate of descent below 2,000 feet by airport by fleet type. This may be useful to better understand the meaning of the data once related events indicate that this is an area requiring investigation. This analysis may suggest that all fleets are experiencing high descent rates at a certain airport or just a specific aircraft type. This type of information can be used to pinpoint the potential source of the problem and, hopefully, suggest the nature of appropriate corrective action.

(5) Data that could be employed to determine flight crewmember identity are removed from view in the electronic record as part of the initial processing of the airborne data. However, air carrier FOQA programs typically provide for a gatekeeper, who is provided with a secure means of determining identifying information for a limited period of time, in order to enable follow-up inquiry with the specific flightcrew associated with a particular FOQA event. Such contact is usually limited to situations when further insight into the circumstances surrounding an event is needed. The gatekeeper is typically a line captain designated by the air carrier's pilot association (if applicable). The concurrence of the gatekeeper is required in order to initiate a follow-up with an individual pilot. Follow-up inquiries with individual crewmembers concerning FOQA events will normally be accomplished by a line captain designated as a gatekeeper by the air carrier's pilot association (if applicable).

c. FOQA Analysis Process.

(1) Overview. The FOQA analysis process must be developed based on the objective and scope of the intended program. At a minimum, the process will be determined depending on whether information will be used to evaluate or effect change in any or all of the following areas:

- Operational Safety
- Aircraft Performance
- Aircraft System Performance
- Crew Performance
- Company Procedures
- Training Programs
- Training Effectiveness
- Aircraft Design
- ATC System Operation
- Airport Operational Issues
- Meteorological Issues

NOTE: Data analysis may be different for each of these groups, depending on the intended use of the information. What type of analysis is available will be a function of the aircraft recording capability, available parameters, and GDRAS hardware and software capabilities. Extensive coordination between the FOQA FMT and other airline departments is crucial in maximizing analysis capabilities within the FOQA program.

(2) Data Recording. The available parameters and their associated sample rates and recording accuracies will directly affect FOQA analysis. The minimum core recorded parameters are those specified in part 121, sections 121.343 and 121.344 for FDRs. Aircraft that have been further outfitted with programmable FDAUs or DMUs may have parameters in excess of the minimum required. FDAUs or DMUs can be programmed to provide these additional parameters dependent upon storage medium capability. These FDAUs and DMUs may also be able to modify the sample rate through reprogramming. This will be a function of the parameter sensor on the aircraft and recorder medium size. Close coordination with operator engineering personnel will be required to identify available parameters.

(3) Analysis Techniques. Two types of analysis techniques can be applied to FOQA data. They are parameter exceedence analysis and statistical analysis.

(a) Exceedence Analysis. This involves setting a specific limit for the GDRAS to detect for a particular parameter. For example, the GDRAS can be programmed to detect each time the aircraft roll angle exceeds 45 degrees. This data can be trended over multiple flights to determine the number of exceedence occurring per flight segment. In addition, the data can be trended to determine which phase of flight, airport, or runway, if appropriate, depending on the event type. Levels of exceedence can be programmed for particular events based on the operator's risk assessment to assist in focusing resources on implementing corrective action on the highest perceived operational risk area. A higher level of risk may be associated with an occurrence where the bank angle reached or exceeded 60 degrees. The FMT, through the gatekeeper, may choose to contact the crew or conduct a more detailed investigation of the event for this type of exceedence in addition to just maintaining and monitoring the trends where bank angle exceedences reach 45 degrees or greater. Exceedence levels will have to be developed through assessment of a carrier's operations manuals, training programs, and risk assessment process as part of the overall safety program.

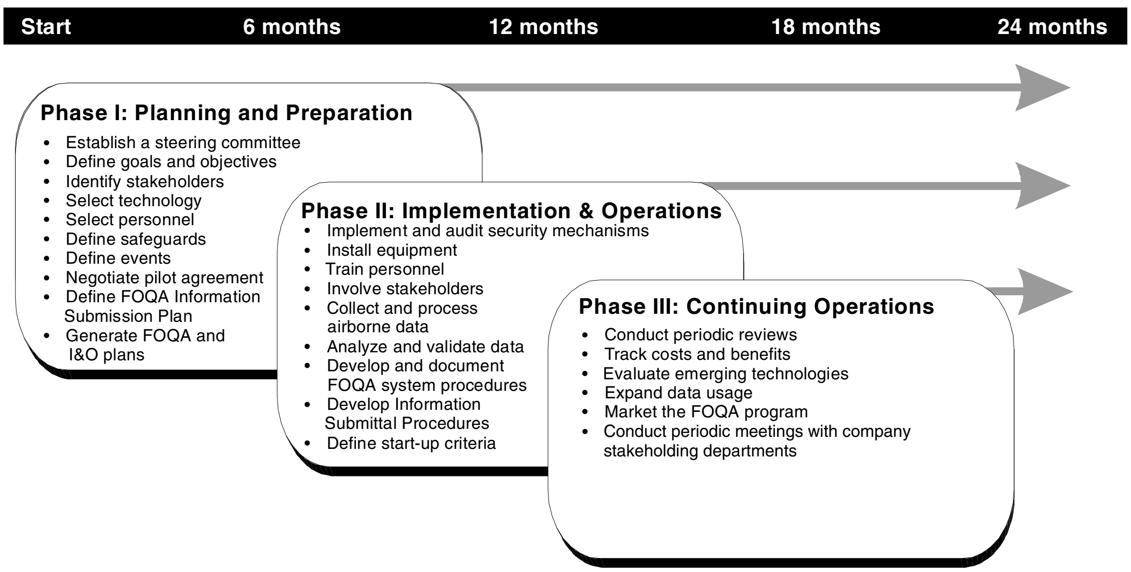
(b) Statistical Analysis. This is used to create profiles of flight, maintenance, or engineering operational procedures. The profiles can use several measurements to build distributions of various criteria. A distribution of data will show all flights and enable a carrier to determine risk based on mean and standard deviations from the mean. One procedure a carrier may look at is approach tracks. A profile would be designed to measure the different criteria of an approach, like airspeed, rate of descent, configuration, or power setting. For example, the GDRAS will capture the maximum airspeed of every flight on final approach. A series of distributions will show a picture of how all flights are performing. The carrier can then determine when an approach track may lead to an unstable approach or landing. Similar to exceedence analysis, statistical analysis can use distributions to drill down into the data to look at phase of flight, airports, or aircraft type, if appropriate. Each individual airline working with its FOQA team could establish or modify airline policy and training programs based on the performance of all its flights. Once a baseline is established, the data could be monitored to track the trend of what is occurring. The value of using statistical analysis is that data from all flights is used to determine risk for an airline without focusing on specific event exceedences. The use of data distributions can develop a risk assessment process by establishing a baseline for trending data and determining critical safety concerns. Statistical analysis is a tool to look at the total performance of an airline's operation.

(c) Validated Trend Information. This is reviewed to determine the nature of any required action. Such actions might include the immediate notification of maintenance personnel if limits were exceeded that require inspection of the aircraft, reviews of the event to identify possible corrective measures, or a determination that further information is needed through crew feedback. Depending on the particular event, the flightcrew may be contacted to gather more information about the circumstances and causes of the event. Corrective measures can range from modifications of flightcrew training to revisions of the operating procedures to equipment redesign. Information on valid events is also stored in databases for use in trend analysis.

7. FOQA PROGRAM ESTABLISHMENT AND IMPLEMENTATION. This section presents guidelines for designing, developing, implementing, and evaluating a FOQA program. These guidelines do not reflect any single FOQA program in operation today. Rather, the guidelines describe the best practices culled from various air carriers that currently operate highly effective FOQA programs. The FAA does not require these guidelines to be followed in order for an air carrier to receive approval for its FOQA program. A successful FOQA program should be customized to address an air carrier's individual needs and situation. Air carriers that are considering establishing a FOQA program should visit with air carriers that have already established FOQA programs. Such meetings are intended to foster a clear understanding of what is involved in the entire process. These discussions can provide useful information and practical know-how regarding lessons learned, obstacles to success, and potential benefits. The three phases of a FOQA program are Planning and Preparation (Phase I), Implementation and Operations (Phase II), and Continuing Operations (Phase III).

NOTE: Each phase contains specific elements, as illustrated in figure 1. Each of these phase elements will be further discussed in the following sections. Activities in each phase may occur in parallel. Also, because implementing a FOQA program is an iterative process, tasks in all phases may be open-ended and continue for the duration of the FOQA program. However, the transition to Phase II begins definitively when the FAA approves the air carrier's I&O Plan.

FIGURE 1. FOQA PHASES



a. Phase I—Planning and Preparation.

(1) Overview. Phase I is the foundation of a FOQA program. This phase begins when the air carrier decides to establish a FOQA program. A FOQA plan that defines the type of system that will meet user needs and how that system will integrate with other areas of the company and stakeholders is then written. Because much of Phase I requires interdepartmental cooperation and communication, many air carriers establish a FOQA steering committee or similar oversight body. During this phase, the air carrier should also establish mechanisms for communicating the current status and progress of the program. These updates should be tailored to the interests of the various users. Planning, organizing, and obtaining resources for a FOQA program can be extremely challenging. The effort required should not be underestimated. Realistic assessments of the required time and resources indicate that designing, developing, and implementing a FOQA program takes months. Educating users and fully realizing the benefits takes even longer.

(2) Establish a Steering Committee. The formation of a FOQA steering committee is optional. However, it is a recommended first step in developing a FOQA program. The steering committee should define its members, meet regularly, and identify all applicable stakeholders early in the process. A typical steering committee might include a senior management member and representatives from flight operations, maintenance, safety, training, and the pilot association, if applicable. As Phase I progresses, the steering committee might invite the purchasing and legal departments to participate. Key issues to be addressed in Phase I are the size and scope of the FOQA program, organizational issues, resources requirements, and support from upper management. Determining where FOQA program responsibility will reside within the organization and ensuring participation of that group or department are important. Experience has shown that the establishment of a steering committee is an important step for the following reasons:

(a) It formalizes the operator's intent to initiate a FOQA program by creating a recognized, corporate-sponsored standing committee. Executive sponsorship demonstrates commitment and fosters this commitment through ongoing communication, thereby ensuring corporate-level understanding of the FOQA program's value as well as its costs. Executive participation also makes FOQA a priority within the organization, supports allocation of required resources, and aids in overcoming any organizational resistance or departmental conflicts.

(b) It provides an early opportunity to identify and include the appropriate stakeholders from various air carrier departments in the FOQA program development process.

(c) It may conceive and articulate the vision for the air carrier's FOQA program. The committee is also a vehicle for communicating that vision to the stakeholders and developing a consensus regarding key program issues.

(d) It can guide the FOQA program through Phase I and the development of the I&O Plan.

(3) Define Goals and Objectives. A key step in Phase I is to clearly define the vision, goals, and objectives of the FOQA program. These goals should be meaningful and measurable, define the expected uses for the FOQA data, identify critical success factors, and be prioritized. Well-defined goals are tools for convincing stakeholders and management why the air carrier should invest in a FOQA program. At the beginning of Phase I, goals will likely be defined broadly, because the air carrier is still determining what the FOQA program will accomplish. By the conclusion of Phase I, a specific set of goals and objectives to achieve in Phase II should be defined.

(4) Involve Stakeholders. To correctly formulate the program's expected output, stakeholders should be identified and involved early in the overall process. Each department is likely to require data analysis/reporting capabilities that are unique to its own needs. Identifying the stakeholders will help to identify their data analysis/reporting requirements, which will facilitate selection of the technology for recording, transporting, analyzing, and disseminating FOQA data. Initial stakeholders should include representatives from safety, flight operations, training, maintenance, engineering, airfield operations or ATC liaison, and the pilot association.

(5) Identify User Needs. The Steering committee should conduct a user needs assessment to develop a better understanding of stakeholder needs and to establish user requirements for the operations, training, engineering, maintenance, or other relevant departments. This study elicits and analyzes users' needs to assist in selecting the proper technology for the program. A clear and comprehensive understanding of the users' needs is essential to the program's success. FOQA's primary benefits are directly related to the usefulness of the data analyses to the stakeholder. Further, the FOQA data analyses need to be distributed intelligently. Determine what pieces of information are valuable to the stakeholder and consider how FOQA data can enhance current processes. An effective user needs assessment may identify user groups reluctant to participate in the FOQA program and help bring them into the program.

(6) Select Technology. Determining the technology and vendors to use is a critical decision. FOQA programs are comprised of at least three interdependent specialized systems. These three systems are airborne data collection, ground data replay and analysis, and data management and analysis. The first generation of programs used by U.S. air carriers was designed around commercial off-the-shelf (COTS) systems similar to those used in European and Pacific Rim FOQA programs. An increase in the number of air carriers implementing FOQA programs has led to an increasing number of vendors and products supporting FOQA programs. The approach taken by these vendors varies widely and the technological solutions offered should be carefully evaluated to assess their suitability to the air carrier's needs. Special consideration should be given to technical issues, such as whether a particular product is compatible with the avionics and bus configurations already on the aircraft. Vendor training, warranty, and support policies are also important considerations in product selection.

(7) Select Personnel. Selecting personnel to staff the FOQA program depends on the program's scope, the size and organization of the air carrier, and the technology that will be implemented to record and analyze information. A typical program includes a FOQA manager, one or more FOQA analysts, and a FMT composed of experienced pilots. FMT members should be technically proficient on the aircraft types used in the FOQA program and have excellent communication and problem-solving skills.

NOTE: In order to obtain perspectives from various interested departments, an air carrier may "share" employees across normal departmental lines. For example, two part-time people (one from the safety department and one from the engineering department) may provide a more synergistic approach than a single full-time analyst devoted only to FOQA.

(8) Define Safeguards. FOQA requires vigilant security and privacy protection for confidentiality of the data and to protect data against unauthorized disclosure, alteration, misuse, or destruction. The issue of data protection and security is sensitive and focuses on the confidentiality of a particular air carrier, flight, date, or flightcrew and a recorded event. The security policy should balance users' needs to access the data against the need to keep the data confidential. From the outset, air carrier policies and procedures for all security and protective aspects of the FOQA program should be carefully designed, documented, implemented, and periodically reviewed. The person responsible for implementing the security policy, such as the gatekeeper, should be identified.

(9) Define Events/ROMs. The events/ROMs that can be defined are dependent upon the available parameters that are recorded on a given aircraft type. Event/ROM definition and modification starts in this phase and continues for the duration of the FOQA program. Typically, the first phase of a FOQA program focuses on a single aircraft type. Information on defining events/ROMs and associated parameters is contained in appendix A.

(10) Negotiate Pilot Agreement (if necessary). Establishing an air carrier FOQA program may necessitate the negotiation of an agreement between the air carrier and its pilots' collective bargaining agent. This agreement defines the specifics of the FOQA program and its objectives and administration. This agreement is crucial for obtaining buy-in from the pilot community and for ensuring that line pilots play an integral part in the process.

(11) Generate FOQA I&O Plan. The FOQA I&O Plan is the most important output of Phase I. The I&O Plan describes key aspects of the FOQA program. Preparing this document is one of the last steps of Phase I. Work done on the FOQA Plan can serve as a basis for the I&O Plan. The I&O Plan must be submitted to the FAA for review and approval in order to obtain protection from FAA civil enforcement actions. See section 13.401(c) for specific guidance for the development of the I&O Plan, including a template and checklist, is provided in appendices A and B.

b. Phase II—Implementation and Operations.

(1) Work-Intensive. Phase II is the most work-intensive phase of a FOQA program. During Phase II, the FMT performs the tasks outlined in the I&O Plan. The airborne and GDRAS equipment selected in Phase I are installed. Phase II initially focuses on a single fleet and a limited number of equipped aircraft (usually 15 to 25). A major milestone in this phase is the first time that the air carrier records FOQA data, processes the data, and performs an analysis. During this phase, activities transition from designing the FOQA program to implementing and administering the program. The FOQA steering committee will begin to function in more of an advisory capacity as the FMT begins to assume its leadership role.

NOTE: Experience has shown that it takes approximately three to six months from when data are first recorded until official program startup can commence. The transition to Phase III occurs when the air carrier is convinced that FOQA data are accurate, reliable, and secure.

(2) Implement and Audit Security Mechanisms. The security policies and procedures defined in Phase I should be implemented and thoroughly tested to see that they are effective. The actual mechanisms for protecting the data will be based on the capabilities of the hardware and software used in the program. The gatekeeper should be trained on how to implement and manage these mechanisms to protect data and control access. All GDRAS users should receive instruction about the protective provisions and how to handle problems. Periodic audits of the security mechanisms should be conducted, and the results should be used to fine-tune the policies and procedures.

(3) Install Equipment. A schedule should be established for installation of all equipment, including airborne and GDRAS. If installation of airborne equipment requires obtaining a Supplemental Type Certificate (STC), additional time and resources must be budgeted for this process. Coordination with maintenance and vendors will be required to track progress and resolve problems.

(4) Train Personnel. Personnel who install airborne systems may require training before or during equipment installations. For the GDRAS, the different levels of users may benefit from separate training classes tailored to their needs. The individual responsible for the GDRAS, typically the FOQA analyst, should receive training on system installation, configuration, and administration. Training for end-users should be tailored to their analysis needs and be provided as close to the initial exposure to the system as possible. End-users should be educated on product usage and the data. The training should occur after the system is fully operational and when the air carrier's actual data are available so that users learn to effectively utilize the system with their data. Additional documentation may need to be developed to supplement materials provided by the vendors and to cover carrier and fleet-specific topics.

(5) Involve Stakeholders. To realize value from the FOQA investment, information derived from FOQA data must reach the appropriate user groups. Stakeholders will value the FOQA program only if they can obtain useful information that was not available before or obtain information faster than they can by using their current methods. The stakeholders will need to know what information is available to them. Education sessions should be held to promote user awareness of the information available, the program's capabilities, and the information's potential uses. Initial education should explain the FOQA program, including concepts, technology, benefits, and implementation schedule. Just because FOQA data are available does not guarantee widespread usage. Follow-up educational sessions may be required and should focus on instructing stakeholders on how to access and use the information available from FOQA data. Using a variety of methods and media (newsletters, e-mail, corporate Intranet, formal presentations, one-on-one meetings, team meetings, and videos) may attract a wider audience to the program than using only a single vehicle.

(6) Collect and Process Airborne Data. Procedures for retrieving the media on which FOQA data are recorded, such as optical disks or Personal Computer Memory Card International Association (PCMCIA) cards, or for downloading data from solid-state recorders using hand-held readers, are needed. These procedures need to be developed and tested for accuracy, completeness, and resource requirements. The procedures should address the retrieval of recorded media, storage and distribution of unrecorded (blank) media, and installation of unrecorded media. Typically, media containing the flight data are removed from the recording device during a scheduled maintenance check. Retrieved media are sent to a central location for transmission or processing. New media are then inserted into the devices for the next round of flights. Schedules for retrieving the media are determined by the capacity of the media, the amount of data recorded, and the schedule of maintenance checks. The media retrieval schedule may range from 3 to 20 days. The same kind of schedule would apply if hand-held download devices were being used. Wireless data link systems, which transmit information directly to a ground system, eliminate the scheduling and staffing logistics associated with media or data retrieval. Using wireless data links may also reduce the potential for data loss when recording media reach capacity.

(7) Analyze and Validate Data. Stakeholder confidence in the FOQA program is directly proportional to the data's accuracy, reliability, and completeness.

(a) Data reliability is determined by validating the integrity of the airborne and ground systems' hardware and software. "Reasonableness" and consistency checks need to be performed on the recorded data. These checks can be accomplished by a variety of means, including:

- Validation by the vendor
- Comparison of Digital Flight Data Recorder (DFDR) data readings with FOQA readings
- Sensor validation
- Comparison of FOQA data with onboard, in-flight observations

(b) Data integrity and validity standards should be established to see that the data and associated analysis and reporting are performed in a consistent, standardized manner.

NOTE: Data validation activities tend to take much longer than anticipated.

1 Event sets will probably need to be fine-tuned after data from the first flights are analyzed to determine that what is being recorded is exactly what is needed and that appropriate data are being recorded at the proper resolution. Faulty sensors, modified LFLs, or missing software updates for acquisition units or analysis programs can cause errors. Fine-tuning event sets is a time-consuming and reiterative process. Failure to properly fine-tune the event sets can yield information of no use to stakeholders or worse, unreliable and invalid data. Appendix A contains a suggested list of events to use (with modifications, as needed) and analyze in a basic FOQA program.

2 Any modifications to event sets or their associated parameters should be carefully tracked and documented to preserve the integrity of the process. Be aware that changes to event definitions may diminish the usefulness of trend or aggregate data if those data were captured under a combination of old and new event definitions.

(8) Store Data. FOQA programs yield vast quantities of raw data. The average amount of FOQA data collected from a single, digital aircraft is approximately 7.2 megabytes (MB) per day, resulting in 2.6 gigabytes (GB) per year. The air carrier that fails to plan ahead for data storage from all the aircraft covered will soon be awash in data. Although air carriers may choose to retain only a small portion of these data, establishing and maintaining a data storage program is critical for success.

(9) Develop and Document FOQA Program Procedures. As the program transitions through shakedown to production status, the FMT should develop and document procedures for operating and managing the program.

(a) Manual and/or automated procedures should be developed and documented for data security and data management (including backup and recovery, data archiving and restoration, monitoring and fine-tuning databases, defining and fine-tuning event sets, and data de-identification). Written procedures describe how to:

- Define, update, and delete user accounts
- Manage libraries of reports and graphics created by users
- Control security and access permissions for users and groups

(b) Documentation of all procedures is important for promoting consistent administration of the program. The importance of good documentation becomes evident when there are personnel changes on the FMT.

(10) Satisfy Startup Criteria. The criteria that indicate when a FOQA program is official and can transition from shakedown status into a mode of formal continuing operation should be established. The official start date defines when FOQA data will be used for formal analysis and trending. The FOQA manager and members of the FMT should periodically review the startup criteria to identify and correct problem areas, as well as certify criteria completion. Satisfaction of the startup criteria heralds the start of Phase III.

c. Phase III—Continuing Operations.

(1) Startup Criteria. Phase III begins once the startup criteria have been satisfied. Airborne and ground-based data systems must have been tested and confirmed, data accuracy and integrity must have been checked, and methods of analysis must be validated. At this phase, the FOQA program has stability, reliably providing high-quality, readily usable data to the FOQA program's stakeholders.

(2) Iteration and Review. Phase III shifts the focus from implementing the technology to optimizing available data and the processes required to obtain the desired information. Periodic reviews of all aspects of the FOQA program will determine whether the program is working as well as it could or whether revisions are required. These reviews will also identify when the program needs to be updated and modernized. Air carriers typically go through several iterations of experimentation and learning before mature FOQA processes are achieved. Following the full cycle of analysis, design, implementation, operation, and evaluation for each iteration of upgrade or change is important. At the end of each iteration, the lessons the team has learned should be captured and documented so that subsequent efforts benefit from the team's experience.

(3) FOQA Program Changes. Changes are likely to occur in an air carrier's FOQA program as air carriers assimilate new technologies, modify event definitions, and change structures to meet the stakeholders' growing needs. When changes to an air carrier's FOQA program result in disparities between the program as implemented and the program as documented in the approved I&O Plan, the I&O Plan should be modified accordingly and changes must be submitted for acceptance by the FAA in order for section 13.401(c) to continue to apply to the FOQA program.

(4) FOQA Program Expansion. A FOQA program is neither static nor finite. It is meant to undergo controlled expansion and evolution as stakeholder demand for information grows and new technologies become available. The program should be able to accommodate new uses for FOQA data. These may require new equipment to capture and analyze the data. Additional stakeholders may wish to make use of available FOQA information. Once successes are achieved, the process of expanding usage of FOQA information will likely accelerate. The real payback begins when FOQA capabilities are widely recognized and used throughout the air carrier. Phase III has no distinct end-point. It is deliberately "open-ended" to allow for enhancements to airborne, ground, and processing system technology; to allow program expansion to other fleets; and to allow broadened data usage. The program's long-term plans will span several years, but incremental evolution should occur in carefully planned and well-documented 6- to 12-month cycles.

(5) Communicate FOQA Program Benefits. A comprehensive program to continuously promote FOQA should be established, along with mechanisms for implementation. The FOQA promotion effort should focus on gaining widespread support for the program. A variety of communication methods should be considered. For example, a newsletter can be used to inform users of significant program accomplishments, additional capabilities, and program evolution. Bulletin boards in pilot crew rooms are useful in disseminating FOQA information. Video presentations on FOQA findings might be useful in pilot annual recurrent training classes. Speaking at departmental and staff meetings and publishing testimonials about FOQA successes are also useful methods to spread the word about the program's progress.

(6) Conduct Program-Wide Periodic Reviews. Periodic reviews and assessments should be conducted to determine that the program stays relevant to stakeholders' new and existing interests and to identify areas for potential improvements. These assessments should determine if anticipated benefits are being realized and whether the information provided to end-users is accurate, timely, and usable. Ongoing user feedback mechanisms can be a valuable tool for capturing comments on the efficacy, usefulness, perceived shortcomings, and desired improvements of the current program. Likewise, efforts should be made to maintain current awareness of new technological alternatives and product enhancements. An audit of the quality of the aggregate data should also be performed along with an assessment of the accuracy of the reference and descriptive information. The tools employed to create aggregate and trend data should be periodically reviewed to determine if new technology would be more effective.

(7) Track Costs and Benefits. Justifying the investment in a FOQA program is an ongoing task. Capturing the initial acquisition and recurring costs is straightforward, as long as all categories of recurring costs are identified. Tracking the less tangible benefits is much more difficult. Benefits of a FOQA program, savings achieved and costs avoided, are spread across many departments. The safety department is an obvious beneficiary. However, placing a dollar value on an unknown number of aircraft accidents or incidents that were prevented because of

FOQA is almost impossible. The training department benefits from more effective training that is focused on documented problem areas, rather than using a standard syllabus that may not address areas where pilots are having problems. The maintenance department benefits from FOQA because of improved monitoring and documentation of maintenance problems, as well as having more data available for timely troubleshooting. This may result in fewer unscheduled component changes, better preventive maintenance procedures, and reduced requirements for spare part inventories.

(8) Evaluate Emerging Technologies. As the air carrier's FOQA program expands to cover greater numbers of aircraft and fleets, the ability of current systems to accommodate growth and change should be carefully considered. Emerging technologies have the potential to increase the efficiency and effectiveness of all facets of a FOQA program. For example, newer data capture devices may be able to record more parameters more frequently, the handling of recorded data may require less human intervention, analysis programs may become more automated, and new visualization capabilities may enhance the ability to understand flights and events. Technological advances can also provide solutions for many of the day-to-day data handling problems that FOQA generates. During the next few years, the market for FOQA equipment may grow rapidly and vendors may offer new products and technology. Keeping apprised of new technologies can help to optimize the overall investment in a FOQA program.

(9) Expand Data Usage. Expansion of data analysis is controlled by the limitations of the data generated by the GDRAS and the degree to which the data are stored in proprietary formats. COTS products can be used for statistical analysis and data mining, particularly when GDRAS supports industry standards for data access and exchange. The integration of FOQA data with other internal safety-related programs (such as the Aviation Safety Action Program (ASAP)) should be considered to further enhance the safety value of the information.

(10) FOQA Meetings. Conduct periodic FOQA meetings (preferably every 30 days) to provide company stakeholders with updated trends, information, and evaluation of previously implemented corrective actions.

8. INFORMATION-SHARING WITH THE FAA AND INDUSTRY. Section 13.401 requires operators of approved FOQA programs to provide the FAA with aggregate FOQA data in a form and manner acceptable to the Administrator. There are various ways and levels on which to accomplish this sharing, which are described below. The operator's director of safety or designated representative should be responsible for approving the release of de-identified aggregate FOQA data to any third party after obtaining the prior input and approval of all appropriate parties within the carrier, including the pilot association (if applicable).

a. Regular Briefings with the FAA Certificate Management Office (CMO). The first level of sharing is between the carrier and its local CMO/Flight Standards district office (FSDO). To accomplish this, a regular meeting should be established with local FAA personnel, as identified in the operator's FAA-approved I&O plan, to review FOQA program status and data trend analysis. Scheduling of these meetings should at least be quarterly, but can be held more often depending on the scope of the operator's FOQA program. Normally, this meeting is held on the operator's property and does not include the physical exchange of data, but a review of trend analysis and corrective action plans. Aggregate data has been further clarified by the FOQA Aviation Rulemaking Committee (ARC) as the de-identified summary, statistical FOQA information that is normally acquired within a carrier's FAA-approved FOQA program. The degree of data de-identification will be determined by the respective air carrier, as described in its approved FOQA I&O Plan. For these briefings, the carrier may provide the aggregate data in oral, written, graphical, or digital format.

b. Intra-Carrier Information-Sharing. The sharing of FOQA information from an operator's program with other operators can provide benefits to an operator's overall safety program. This sharing can be accomplished through industry associations or directly between operators depending on the scope of the issue. Issues such as ATC or issues specific to a particular aircraft type are examples of subjects that can be shared between operators. Maintaining confidentiality of the information between operators is important in providing a cooperative environment.

c. Industry Sharing with the FAA. Issues may be identified from FOQA data that can't be solved through modifications or enhancements to an operator's existing operational procedures or approved training programs or through aircraft modifications under the control of the carrier. Also, issues may not be evident when individual carrier information is viewed independently. Therefore, industry sharing with the FAA may be helpful in identifying and resolving broad, industry issues. The FAA, working with carriers, has adopted an incremental approach to this requirement. The specific provisions of this approach will be developed over time in collaboration with the FOQA ARC and operators of approved programs. As an interim means of establishing initial compliance with section 13.401, operators of approved FOQA programs should provide the FAA with at least quarterly briefings on observed trends. These operators should also provide any other applicable information of potential safety significance. The FAA will specify the location of the briefing. For the purpose of these briefings, carriers may provide the aggregate data in oral, written, graphical or digital format. As the FOQA ARC works collaboratively with the FAA to develop a more systematic approach to the future sharing of aggregate FOQA information, guidance to industry on acceptable means of compliance with section 13.401 will be updated as appropriate.

d. Need for Appropriate Background and Expertise. While it is recognized that the sharing of FOQA information between operators and the FAA has significant potential for identifying system safety issues, FOQA data (even in aggregate form) has important limitations. A detailed understanding of the operator's route structure, equipment types, operating procedures, measurement criteria, and data collection procedures is required so that conclusions drawn from FOQA data will result in effective or productive safety interventions. Analysis of FOQA data should be accomplished by the operator and/or trained representatives from the operator's pilot association (if applicable) and by individuals thoroughly familiar with its characteristics. FOQA data analysis is a tool for managing safe operations, not an independent objective. FOQA is but one element of a comprehensive operator safety program.

9. FOQA IMPLEMENTATION AND OPERATIONS PLAN.

a. Overview and Plan Development.

(1) Under section 13.401, an operator seeking protection from the use of FOQA data for enforcement by the FAA must obtain FAA approval of its FOQA I&O Plan. The document that describes an air carrier's FOQA program for FAA approval purposes is the FOQA I&O Plan. A FOQA I&O Plan is submitted to the FAA for review and approval, as described in paragraph 9a(2) of this AC. The FAA will determine whether an air carrier's FOQA program is approved and notify the air carrier by letter of any concerns and/or formal approval.

(2) The I&O Plan specifies the organization, technology, policies, procedures, and operational processes used by a certificate holder for its FOQA program. The FAA approval process for an I&O Plan is designed so the air carrier has identified adequate procedures, organizational resources, and material resources to collect, analyze, and act upon information provided by the FOQA data. The I&O Plan should describe the following elements:

(a) Program goals.

(b) Fleet(s) to be equipped for FOQA.

(c) Airborne hardware, analysis software, and other equipment to be used in the program.

(d) Organizational structure for the FOQA program.

(e) FOQA program personnel and associated roles and responsibilities.

(f) Procedures for data acquisition and handling.

(g) Procedures for data analysis and reporting.

(h) Procedures to implement corrective action(s) when adverse safety trends are discovered.

(i) Policies on data retention, data security, and crew contact.

(j) Policies on providing FAA with de-identified aggregate data on the operator's premises and information on corrective actions undertaken.

(k) Policies and procedures for maintaining and revising the I&O Plan.

(l) A glossary of terms used in the I&O Plan.

(m) Appendices, which should include:

- A copy of the Letter of Agreement on FOQA with the pilots' collective bargaining unit (if applicable)

- List of events, parameters, and threshold values to be used in the program for each FOQA-equipped aircraft fleet
- A list of the documents referenced or cited

(3) An air carrier should identify its planned FOQA airborne and ground-based equipment in its initial I&O Plan. Subsequent revisions of the I&O Plan should identify any changes to the planned or implemented equipment. The purpose of this information is to ascertain proposed system capabilities, rather than to approve an air carrier's selection of a particular brand or vendor. Decisions with respect to the selection of software and equipment vendors are left entirely to the air carrier. However, the FAA may assess, for the initial plan and any subsequent revisions, whether the proposed products' functionality appears to be adequate to accomplish the program's goals.

(4) The FAA prefers to interact closely with applicants during the development of the I&O Plan, rather than to wait for the formal submittal of the finished plan before establishing substantive dialogue. A discussion and review of rough drafts of document sections early in the development process will facilitate approval. The submittal of the final documents then becomes a formality, with minimal changes required.

(5) To assist air carriers in developing their I&O Plans, a checklist of items to be included in the plan is provided in paragraph 9a(3). Paragraph 9a(4) contains a sample I&O Plan template. Although specific areas should be addressed in the plan, the I&O Plan template is flexible enough to allow the air carrier to tailor the plan to its individual needs.

b. FAA Approval.

(1) Operators seeking approval of a FOQA I&O Plan should submit the plan and a completed I&O Plan checklist to the FAA. The checklist should be used as an aid to see that all required material is included in the plan. The submittal should include a cover letter addressed to the air carrier's assigned Principal Operations Inspector (POI) that requests approval of the plan. A copy of the cover letter, plan, and checklist should be sent simultaneously to HQ FAA, Attn: AFS-230. Electronic transmission of this documentation to AFS-230, Volunteer Safety Program Branch, is encouraged (for which purpose signatures are not required).

(2) The FAA will evaluate the I&O Plan based on the adequacy of the proposed means and methods identified for the collection and analysis of data, as well as procedures for taking corrective actions. The joint evaluation by AFS-230 and the POI will allow the FAA to maintain standardization and continuity throughout the industry while accommodating carrier-specific organization and resource differences best understood by the POI.

(3) The POI and AFS-230 will review the proposed I&O Plan and establish a consensus as to whether the plan should be approved. The FAA procedures for I&O Plan approval are contained in FAA Order 8400.10, Air Transportation Operations Inspector's Handbook. AFS-230 and the POI will communicate any plan inadequacies to the air carrier in writing. Similarly, once AFS-230 and the POI concur that the plan should be approved, the air carrier will receive an approval letter with the signatures of the POI and the manager of AFS-230. Once an I&O Plan is approved by the FAA, the air carrier's FOQA program may continue for an indefinite period, unless the carrier elects to terminate the FOQA program or the FAA withdraws its approval.

(4) The I&O Plan is a "living document" and should be updated as necessary. Changes will occur in the FOQA program as an air carrier assimilates new technologies, adds new fleets, modifies event definitions, and changes structures to meet its program's growing needs. Changes are likely to be particularly frequent during the early stages of an operator's FOQA program. When changes occur to previously approved I&O Plan content, the I&O Plan should be revised to incorporate those changes.

(5) A revision control methodology should be established for the I&O Plan (and any subsequent revisions) and included in the I&O Plan. A list of affected pages, or a revision control page that identifies the pages to be added/removed/replaced, should be submitted with any revised pages. Each revised page should contain the page number, revision number, and revision date. Revisions to the I&O Plan are required whenever changes occur to the nature of the FOQA program (e.g., changes to fleet composition, system configuration, flight operating procedures, organizational structure, schedule, and key milestones).

(6) Revisions to approved I&O Plans do not require FAA letters of approval. Because such changes can be potentially frequent and voluminous, revisions to approved plans will be considered to be accepted by the FAA, unless the FAA notifies the carrier in writing within 45 days of revision submittal that the revision is not accepted, except as follows: notwithstanding this 45 day period, if at any time the FAA discovers that the content of a FOQA I&O Plan is not consistent with section 13.401, or is otherwise unacceptable to the FAA, the FAA may notify the operator that revisions are required in order to maintain program approval. In addition to the POI, AFS-230 should be provided with an information copy of all revisions. The POI may permit an air carrier to consolidate and submit revisions on a quarterly basis throughout the calendar year, rather than submit each revision as it occurs. The air carrier should request this authority from the POI. This procedure is intended to reduce workload for the air carrier and FAA.

(7) FOQA is a voluntary program, and the air carrier may elect at any time to terminate its program. The FAA may also elect at any time to withdraw approval of an air carrier's I&O Plan for failure to comply with the requirements of section 13.410. The protections from civil enforcement actions are predicated upon the expectation that the operator will act upon FOQA information indicative of an adverse safety trend or a continuing violation. If the FAA determines that insufficient effort to develop or implement a plan of corrective action is taking place, and the air carrier is not responsive to FAA efforts to elicit compliance with this requirement, withdrawal of program approval may be appropriate. Withdrawal of FAA approval of the I&O Plan will be transmitted, in writing, to the air carrier.

c. I&O Plan—Topics. The following topics should be included in an I&O Plan:

(1) Background. This section summarizes the foundation and relevant FAA references for FOQA programs.

(2) Introduction. The introduction section should state the goals and objectives of the airline's FOQA program.

(3) FOQA Program Stakeholders. This section should identify the key stakeholders in the FOQA program. There may also be stakeholders outside the company that should be identified here.

(4) Protective Provisions, Pilot Association Agreement (if Applicable), and Corporate Policy Statement. Summarize the salient points of the protective provisions that the airline and its pilots are afforded from FAA certificate action or civil penalties from information and data collected and analyzed by the FOQA program. In addition, the protective provisions from the pilots association agreement should be summarized. Provide a copy of the agreement in Appendix 1 of the I&O Plan. If a pilot association agreement is not applicable to the airline, a corporate policy statement should be included in the I&O Plan that establishes protective provisions to its pilots against disciplinary or other pejorative action from the airline from data or information produced by the FOQA program.

(5) Data Protective Provisions and Security.

(a) In this section, include a summary of the protective provisions to be incorporated into the FOQA program that will gain acceptance by all participants, including the pilot association (if applicable).

(b) Describe the pilot association agreement (if applicable) as it pertains to individual protection and data usage. At a minimum, discuss the following security considerations:

- The team member(s) responsible for data protection and security
- Data protection methods (including those provided by the GDRAS, physical security of FOQA media and facilities and information dissemination safeguards, etc.)
- De-identification requirements and procedures
- Methods for ensuring confidentiality
- Data retention policies and procedures
- Data storage policies and procedures
- Procedures for auditing and refining the security policy, methods, and procedures

(6) FOQA Program Components. Describe the specific technology components proposed for use in the FOQA program. The I&O Plan will need to be amended when changes or additions to the fleet types or changes to other technology components are made in the airline's FOQA program. Program components described should include the following:

(a) Aircraft Fleet. Describe the following:

- How the initial aircraft fleet(s) were selected for participation in the FOQA program
- Number of parameters to be collected from each fleet
- Future plans for program expansion to additional fleets and aircraft within the current fleet

(b) Airborne Data Acquisition System. Describe the selection criteria and product selection process.

- What technical criteria were evaluated (recording capacity, media handling, and download capabilities)?
- How were service and support considered (warranty, repair station locations)?
- What compatibility issues with existing systems were raised (power considerations, size, weight)?

(c) Describe the airborne system configuration and provide information concerning the following:

- Strategy for acquiring airborne data
- Equipment to be installed in the aircraft (including vendor, part number, and other pertinent information) and the technology to be used
- Availability of the STC for each component installed on the aircraft or the plan for obtaining an STC
- Method used for loading and maintaining the LFL
- Fleet installation plan, including equipment installation requirements and schedule
- Support to be provided by the vendor (including a description of repair facilities and warranty policies)

(7) Airborne System Maintenance and Support. Describe whose responsibility it is within the operator to maintain the airborne acquisition and recording system, including parameter maps and configuration. This should also include interface between the FOQA FMT and the responsible party.

(8) GDRAS. Describe the GDRAS selection criteria and product selection process. Describe the GDRAS to be used for the FOQA program, including:

- Specify the vendor, product name, hardware, software, operating system configuration, and communication network
- Summarize the proposed GDRAS's functionality
- Describe vendor support and training
- Specify how LFLs, events, and parameters are defined, configured, and maintained
- Describe user configuration capabilities

- Describe how the system complies with de-identification and security requirements defined by the air carrier and pilot association

(9) Other Equipment. Describe any other FOQA components, such as:

- Software for trend analysis, statistical analysis, and flight animation
- Remote data collection systems and communication infrastructure, as applicable
- The vendor, product name, and associated hardware, software, communication, and operating system requirements
- The selection criteria and product selection process

(10) Equipment Upgrade, Modification, or Replacement. Describe the procedures, including criteria, which will be used for upgrading, modifying, or replacing the FOQA program components once those components have been approved for use.

(11) FOQA Organization. This section explains the context of the FOQA program within the air carrier's departmental settings and the individuals who will serve on the FOQA program team. The following subsections contain topics that should be incorporated into the I&O Plan:

(a) Organization Structure. Describe the following:

- The organization and management of the FOQA program, including the organizational entity responsible for the FOQA program
- Any oversight body (such as a steering committee or FOQA committee), including information on membership, charter, duties, meeting schedule.
- Provide an organizational chart that illustrates the organization and management structure of the FOQA program

(b) Personnel. Describe the skills, knowledge, duties, and responsibilities of the following anticipated key personnel associated with the FOQA program:

- Person providing corporate oversight
- FOQA manager
- Gatekeepers
- FOQA analyst
- FOQA intern, if applicable
- Members of the FMT, along with any other committees in the organizational structure

(12) FOQA Program Implementation.

(a) Describe the air carrier's concept of the FOQA program. Include operational procedures for:

- Data processing and analysis

- Investigating results
- Determining corrective actions to be taken for significant events
- Communicating findings to all effected stakeholders
- Obtaining feedback and follow-up for corrective actions
- Data trending
- Generating periodic reports
- Providing local FAA with aggregate FOQA information on the operator's premises

(b) The FOQA Implementation Process. Describe the following:

1 Schedule and timeline for FOQA implementation, including required resources.

2 Training that will be provided to team members and key stakeholders.

3 Location of FOQA facilities, including central processing and any remote sites.

4 Program startup criteria, including milestones (e.g. on system training, education, infrastructure, data validation) that should be met before collected data are used for analysis of line operations. If a user needs assessment has been conducted, summarize the methods used, users interviewed, and results.

NOTE: When developing a scheduled timeline for starting a FOQA program, many of these tasks may require considerable time for completion (i.e., beyond the month in which they are listed as occurring) and that preliminary work will have commenced on these tasks prior to where they appear on the checklist. Obtaining financial approvals and commitments for equipment expenditures and personnel, contracting for equipment purchases, and delivery of equipment may all have very long lead times.

(13) Education and training. Describe the following:

- How officers, senior management, team members, and stakeholders will be educated about the FOQA program
- How pilots will be educated about the program
- How team members will be trained

(14) Data Analysis Procedures.

(a) Data Usage and Management. Describe the anticipated usage of FOQA data for safety, operations, training, and maintenance/engineering. Also describe the framework/technology architecture that will be used for managing the data.

(b) Flight Data Collection and Analysis. Describe the following:

- Procedures for the physical retrieval of data from aircraft

- Procedures for transferring data from airborne systems to the GDRAS, including media logistics and schedule for data retrieval
- Manual and automated methods to verify the quality and integrity of collected data, including any data quality standards
- Methods for logging and tracking airborne-collected data
- Procedures for handling invalid data and diagnosing airborne equipment problems
- Include a process flow diagram that shows the transit and direction of FOQA data through the system, including key systems, entities, and decision points

(c) Data Classifications and Definitions. Describe the following:

- Team member(s) involved in developing the event set
- Methods used to develop the event set
- Source documents
- Event categories, classifications, and severity levels

NOTE: Provide initial event set classifications by operational mode in Appendix B.

(d) Data Definition Maintenance.

1 Describe how event definitions will be validated, reviewed, and defined by the FMT. The following boilerplate can be used as a baseline, but should be modified, as appropriate, to the air carrier's specific situation:

NOTE: Documentation of event definition, validation, and modification will be maintained in the FOQA office and will be made available on request.

2 Also, describe the following:

- Procedures for validating, reviewing, and refining event definitions
- Procedures for creating and verifying new events
- Procedures for tracking modifications to event definitions

(e) Data Review and Evaluation. Describe the following:

- Procedures for periodic review of FOQA event data and trends, including personnel responsible and proposed schedule for review of data and trends
- Procedures for joint FAA/air carrier periodic review of aggregate trend data
- Procedures for notifying appropriate personnel (e.g., flightcrews, engineering/maintenance, and training) about events requiring immediate action
- Processes for maintaining event information for trend analysis, including databases and methods to have invalid events and associated data removed

- Procedures for generating periodic reports to convey FOQA trends and findings
- Methods for detecting and analyzing data trends
- Procedures for crew contact and follow-up
- Procedures for determining corrective actions to be taken for identified events and/or trends
- Methods for obtaining feedback/follow-up for resolution

(f) Data Trending and Record Retention. Describe the following:

- The data retention policy for FOQA data and trend analyses, which should include requirements by maintenance to satisfy manufacturer warranty claims
- Archiving procedures and process for archiving and retrieval of archived data

(15) Program and Data Documentation. Describe how this I&O Plan will be maintained, who the review process will involve, how changes will be tracked, and how revisions will be submitted to the FAA. With the approval of the POI, the air carrier may submit quarterly updates of the I&O Plan to reflect changes that were made during the preceding quarter.

(a) Operational Development. Describe the overall development of FOQA program documentation in support of the program in cases of personnel transitions or program changes.

(b) Information and Data Control. Describe how changes to the FOQA Program will be documented. This should include the following:

- A description of the identified use
- Analysis that was accomplished
- Specific corrective actions or recommendations taken or made
- Personnel who were notified
- Resolution of actions or recommendations

(c) I&O Plan Revision Control. A revision control methodology should be incorporated into the I&O plan. This revision control methodology should include controls for page revisions, deletions, or replacements. The I&O Plan should also stipulate that the operator will submit all revisions to the POI and AFS-230.

(16) FAA Access.

(a) Procedures for joint FAA/air carrier periodic reviews of FOQA program effectiveness.

(b) Procedures for the operator's handling and marking of company proprietary and confidential information submitted to the FAA.

(17) I&O Appendices.

(a) Appendix I (Pilot Association Agreement, if Applicable). If the implementation of the FOQA program depends on obtaining a signed pilot association agreement, insert the agreement or side letter in this section. The agreement should describe how the pilot association will be involved in the operation of the FOQA program.

(b) Appendix II (Event Parameters and Definitions). This appendix should contain list of events and minimum parameters to be monitored and analyzed in a basic FOQA program. When establishing a new FOQA program, the events and parameters in this appendix should provide a good starting point. Note that there are many more parameters available for recording on modern aircraft than are listed in the appendix. Although many such parameters are not used in FOQA event creation, they can be useful to develop a more complete understanding of the causes of events and for aircraft maintenance troubleshooting purposes. Following initial establishment and validation of its program, operators are encouraged to consider expanding upon the basic parameter list provided in this appendix. Ideally, the aircraft fleet initially involved in starting a FOQA program should have a data bus capable of supplying the parameters listed in this appendix and a means of capturing and recording those parameters. It is important to understand, however, that the list of available parameters on any given aircraft will be a result of those provided by the airframe manufacturer, ordered by the air carrier, or a combination of both.

1 Event Selection. Depending on the GDRAS used, selecting events to be included and analyzed can be simple or complex. Developing a list of events from scratch can be extremely time-consuming, particularly during event validation. GDRAS vendors can also create and deliver event sets, but this may entail considerable expense. If an event list is available from another carrier or the list contained in this appendix is adequate, then the event selection process will be relatively simple and much less expensive.

NOTE: The event list should be tailored to the specific air carrier and aircraft type. The parameters used to measure the event need to be recorded on that aircraft type. Next, the tolerances that trigger the events should be set to account for applicable federal regulations, aircraft limitations, and company policies and procedures. The FMT and FOQA analyst should work together to evaluate and adjust event triggers. Since maintenance will also be an important stakeholder, creating events that maintenance would be interested in analyzing would be advantageous.

2 Event Standardization.

(aa) If an operator has multiple aircraft type or model variance within its fleet, attempting to standardize events within the GDRAS analysis function may be advantageous. Numerous events will be common to all types and models of aircraft in an air carrier's fleet (e.g., V_{MO}, M_{MO}, and V_{LE} exceedences). These "common" events can be monitored and analyzed across fleets. However, there will be differences in the triggering limits, which will be dictated by an aircraft's specific operating limitations. Analysis of these events across fleet or model types must account for the difference in triggering.

(bb) To assist in standardization of the analysis, the events can be organized or grouped in different categories. One method of organizing the events could be by "phase of flight." Another method may be to use the sections in the operator's manuals where aircraft limitations or flight procedures are outlined or defined. Users should choose the method that best suits their needs.

(cc) The events may be categorized by the flight phase in which they are most likely to occur, although they may also occur in other phases. However, the flight phase is not used as a discriminator in the creation of these events. Each event is designed to work even if the software used does not use flight phase in its analysis process. The use of flight phase is a common method and may speed the processing of raw data.

(dd) Maintaining documentation of event definitions used in an operator's analysis may be useful. Documentation of the events can assist the operator in validating trend analysis and serves as a guide to program history as events change or are modified during the maturation of the program. Documentation could include the name for specific events, a description that clarifies what the event is designed to measure, suggested event-triggering conditions, the needed parameters to create the event, a possible way of defining the event, and explanatory notes or comments that go beyond the event description. In the event definition, user-defined variables that need to be extracted from Approved Flight Manual (AFM), Flight Operations Manual, Flight Standards/training guidance, or other applicable corporate guidance should also be included.

(ee) Some parameters used in events are derived, meaning they are not directly measured by sensors in the aircraft, but are calculated as part of the processing done by the analysis software. Height Above Takeoff/Touchdown (HAT) is a good example of this. Many events require an altitude component in relation to the airport elevation. This is most accurately done by using the elevation at takeoff or touchdown, calculating altitudes above this elevation, and then measuring actual aircraft performance at these points. There are many possible ways to calculate events, and those presented here may not be compatible with parameters available on a particular aircraft or the capabilities of particular analysis software. Maintaining documentation of events will assist the carrier in trend analysis and the development of events as the program matures. Appendix II of the example I&O plan in Appendix A of this AC contains a representative sample of event documentation.

CAUTION: Each air carrier should review all events to see that the limits defining each event account for applicable federal regulations, airplane flight manual limitations, and company policies and procedures.

(c) Appendix III (Glossary). Definitions of all acronyms used in the document should be included. The definitions should cover more than just what the acronym stands for, the reader should be able to understand what the acronym means. In constructing the glossary, assume that the reader of the I&O Plan is unfamiliar with FOQA, as might be the case with senior management, union officers, legal staff, or local FAA representatives.

(d) Appendix IV (References). Include citations for all referenced documents including, but not limited to:

- Title 14 CFR Part 193, Protection of Voluntarily Submitted Information
- Title 14 CFR Part 13, Section 13.401, Flight Operational Quality Assurance Program
- AC 00-46 (as amended), Aviation Safety Reporting System (ASRS)
- AC 00-58 (as amended), Voluntary Disclosure Reporting Program
- AC 120-59 (as amended), Air Carrier Internal Evaluation Programs: Air Carrier Internal Evaluation-Model Program Guide
- AC 120-66 (as amended), Aviation Safety Action Program
- Flight Safety Foundation, FAA Contract Report, Air Carrier Voluntary Flight Operational Quality Assurance (FOQA) Program, 1992
- General Accounting Office, GAO/RCED-98-10, Aviation Safety—Efforts to Implement Flight Operational Quality Assurance Programs, December 1997

10. APPENDICES.

- Appendix A: Example of a FOQA Implementation and Operations Plan
- Appendix B: FOQA I&O Plan Checklist

11. ABBREVIATIONS

ABBREVIATIONS

Abbreviation	Term
AAC	Airline Administrative Control
AC	Advisory Circular
ACARS	Aircraft Communications Addressing and Reporting System
ACDF	Airline Common Data Format
ACMS	Aircraft Condition Monitoring System
ACSF	Airline Common Statistical Format
AEEC	Airlines Electronic Engineering Committee
AFE	Above Field Elevation
AFM	Approved Flight Manual
AFS	Aviation Flight Standards Service
AFS-230	Volunteer Safety Program Branch
ALPA	Air Line Pilots Association
AOC	Aircraft Operational Control
AQP	Advanced Qualification Program
ARC	Aviation Rulemaking Committee
ARINC	Aeronautical Radio Incorporated
ASAP	Aviation Safety Action Program
ASCII	American Standard Code for Informational Interchange
ASRS	Aviation Safety Reporting System

ABBREVIATIONS

Abbreviation	**Term**
ATC	Air Traffic Control
BASIS	British Airways Safety Information System
CAS	Computed Air Speed
CMO	Certificate Management Office
COTS	Commercial Off-The-Shelf
CSV	Comma Separated Value
CVR	Cockpit Voice Recorder
DAR	Digital ACMS Recorder
DAS	Designated Alteration Station
DAU	Data Acquisition Unit
DBMS	Database Management System
DFDAR	Digital Flight Data Acquisition Recorder
DFDAU	Digital Flight Data Acquisition Unit
DFDMU	Digital Flight Data Management Unit
DFDR	Digital Flight Data Recorder
DMU	Data Management Unit
EGT	Exhaust Gas Temperature
EGT	Exceedance Guidance Team
EMT	Event Monitoring Team
ERC	Event Review Committee
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FDAU	Flight Data Acquisition Unit
FDR	Flight Data Recorder
FMT	FOQA Monitoring Team
FOD	Foreign Object Damage
FOIA	Freedom of Information Act
FOQA	Flight Operational Quality Assurance
FSDO	Flight Standards District Office
g	Gravity (G-Force)

ABBREVIATIONS

Abbreviation	Term
GB	Gigabyte
GDL	Ground Data Link
GDRAS	Ground Data Replay and Analysis System
GPWS	Ground Proximity Warning System
HAA	Height Above Airport
HAT	Height Above Takeoff/Touchdown
HQ	Headquarters
HTML	Hypertext Markup Language
I&O	Implementation and Operations
IT/IS	Information Technology/Information Systems
LAN	Local Area Network
LFL	Logical Frame Layout
LRU	Line Replaceable Unit
MB	Megabyte
MEL	Minimum Equipment List
M_{MO}	Maximum Mach Operating Speed
MTBF	Mean Time Between Failure
N_1	Low Pressure Compressor
N_2	High/Intermediate Pressure Compressor
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NTSB	National Transportation Safety Board
ODBC	Open Database Connectivity
OQAR	Optical Quick Access Recorder
Order 8400.10	Air Transportation Operation's Inspectors Handbook
PAI	Principal Avionics Inspector
PCMCIA	Personal Computer Memory Card International Association
PDF	Portable Document Format
PMI	Principal Maintenance Inspector
POI	Principal Operations Inspector
PPH	Pounds Per Hour
PPM	Partial Program Manager
PSI	Pounds Per Square Inch
QA	Quality Assurance
QAR	Quick Access Recorder
RA	Traffic Alert and Collision Avoidance System (TCAS) Resolution Advisories
RFP	Request for Proposal
ROM	Routine Operational Measurement
SRU	Shop Replaceable Unit
SSFDR	Solid State DFDR
STC	Supplemental Type Certificate

ABBREVIATIONS

Abbreviation	**Term**
TA	Traffic Alert and Collision Avoidance System (TCAS) Traffic Advisories
TC	Type Certificate
TCAS	Traffic Alert and Collision Avoidance System
TE	Triggered Event
V_1	Critical Engine Failure Speed
V_2	Takeoff Safety Speed
V_{LE}	Maximum Landing Gear Extend Speed
V_{MO}	Maximum Operating Limit Speed
V_{REF}	Reference Velocity
WAN	Wide Area Network
WDL	Wireless Data Link
14 CFR	Title 14 of the Code of Federal Regulations
49 U.S.C.	Title 49 of the United States Code

/s/ James J. Ballough
Director, Flight Standards Service

APPENDIX A. EXAMPLE OF A FOQA IMPLEMENTATION AND OPERATIONS PLAN

This section contains an example of an Implementation and Operations (I&O) Plan. Section numbering and section names in this example are suggestions only. They represent the topics that should be included in the I&O Plan. The text of this example is boilerplate content only. It should be used as a baseline and modified accordingly. Instances of [Airline Name] should be replaced with the name of the actual air carrier or operator. Name references to particular equipment should also be modified appropriately.

1. BACKGROUND

Flight Operational Quality Assurance (FOQA) is defined as a program to improve flight safety by providing more information about, and greater insight into, the total flight operations environment through selective automated recording and analysis of data generated during flight operations. Analysis of FOQA data can reveal situations that require improved operating, training, and maintenance procedures, practices, equipment, and infrastructure.

In support of the public safety objective, the FAA has publicly endorsed the development and implementation of voluntary FOQA programs as a tool for continuously monitoring and evaluating operational practices and procedures. In Advisory Circular (AC) 120-59 (as amended), Air Carrier Internal Evaluation Programs, the FAA states, "public safety is enhanced if deficiencies are identified and immediately corrected when they are discovered by the certificate holder rather than when they are discovered by the FAA." FOQA programs can provide the quantitative and objective information needed to identify deficiencies during the certificate holder's internal audit and evaluation process.

FOQA programs are based on the premise that air carriers have primary responsibility for continuously monitoring and ensuring that their operations are safe and in compliance with their operating standards and the regulations. A FOQA program will assist [Airline Name] in identifying and addressing operational deficiencies and trends that are not generally detectable with other procedures. Additionally, analysis of some FOQA program data may contribute to improved safety and efficiency in the design and operations of air traffic control (ATC) systems, aircraft, and airports. Many potential applications of FOQA data have been identified to date. These applications aim to improve safety, evaluate and enhance training practices, revise operating procedures, assist aircraft engineering programs, improve maintenance efficiency, and assist manufacturers in aircraft design and modification.

Several foreign air carriers have successfully implemented FOQA-type programs that use flight-recorded data to improve operational safety and performance. Lengthy track records in effective usage of this information (over 20 years in the cases of British Airways and Scandinavian Airlines System) have provided foreign carriers with clear evidence that FOQA program data represent a source of valuable information that, when used appropriately, can contribute greatly to aviation safety. Airlines that currently have FOQA-type programs agree that the insights derived from these programs have prevented serious incidents and accidents and have led to improved operating efficiencies.

FOQA information can be included in the voluntary audits and evaluations described in AC 120-59 to determine the causes of deficiencies and to suggest enhancements to operating practices. Title 14 of the Code of Federal Regulations (14 CFR) part 13 states the conditions under which information obtained from an approved voluntary FOQA program will not be used in legal enforcement actions against an operator or its employees. In addition, 14 CFR part 193 contains provisions for certain protection from public disclosure of voluntarily submitted safety related information, when such information has been designated by an FAA order as protected from disclosure under that part.

2. INTRODUCTION

The I&O Plan presented in this document specifies the organization, technology, policies, procedures, and operational processes used in the [Airline Name] FOQA program.

The core objective and intent of the [Airline Name] FOQA program is to facilitate the free flow of safety information. The FOQA program will:

1. Collect operational flight data.
2. Develop methods to analyze the collected flight data, such as triggered events and routine operational measurements.
3. Establish procedures for comparing the collected data with established procedures and standards and the use of analyzed data in formal awareness and feedback programs to enhance safety in the following areas:

    a. Flight procedures
    b. Flight training procedures and qualification standards
    c. Crew performance in all phases of flight
    d. Air traffic control procedures
    e. Aircraft maintenance and engineering programs
    f. Aircraft and airport design and maintenance

4. Perform trend analyses of FOQA data to identify potential problem areas, evaluate corrective actions, and measure performance over time.

3. FOQA PROGRAM STAKEHOLDERS

The FOQA program will provide large amounts of previously unavailable data to significantly improve the problem definition process and allow assessment and resolution of systemic safety and efficiency issues. Beneficiaries or stakeholders within [Airline Name] include, but are not limited to, the following:

1. Flight Safety
2. Flight Training and Standards
3. Flight Operations
4. Maintenance and Engineering
5. Operations Control and Dispatch
6. Pilot Association

Cooperation with stakeholders outside of [Airline Name] will also benefit the [Airline Name] FOQA Program. These stakeholders may include, but are not limited to, the following:

1. FAA
2. NASA
3. ATC
4. Aircraft manufacturers
5. Other industry safety groups.

4. PROTECTIVE PROVISIONS, PILOT ASSOCIATION AGREEMENT (IF APPLICABLE), AND CORPORATE POLICY STATEMENT

Key to the success of the [Airline Name] are specific protective provisions that will protect both [Airline Name] and its employees from FAA certificate action or civil penalties as a result of information and data that are collected and analyzed by the FOQA program. In establishing these protective provisions, [Airline Name] has pursued the following distinct courses of action. [Airline Name] has established a corporate policy endorsed by senior management providing that no pilot shall ever be subject to disciplinary or other pejorative action by [Airline Name] from data or information that is produced by the FOQA program, and [Airline Name] has formalized that policy in a FOQA agreement that has been negotiated and accepted by the [Airline Name] Pilot Association [If applicable]. [Airline Name] will establish procedures for sharing of FOQA trend analysis and other pertinent de-identified data with the FAA, as specified in this I&O Plan. These actions are intended to create a framework of cooperation between the Pilot Association [if applicable], the FAA, and [Airline Name] that will permit the most effective use and analysis of FOQA data.

5. DATA PROTECTIVE PROVISIONS AND SECURITY

General

Key areas that were considered in developing the protective provisions for the FOQA program include:

1. Confidentiality—Provides that the identity of individual crewmembers cannot be associated with any FOQA data, except for the purposes of crew-contact as provided for in this I&O Plan.

1. Anonymity—Provides that any identification of airline flight and/or flightcrews with specific FOQA flight data necessary during an analysis is eliminated permanently at the earliest possible time and in accordance with the pilot association agreement.
2. Data access and control—Identifies data that require protection and assigns overall responsibility for data protection. In addition, data access and control provides guidelines and procedures to protect data; provides authorized access to data, data processing and storage locations; provides authorized access to reports and other data outputs, and requires the destruction of data after the retention period has expired.
3. FOQA facilities—Provides secure, controlled access facilities for all systems, offices, equipment, workstations, computers, and peripherals associated with the FOQA program. Additionally, secure systems will also be provided for storage of all FOQA-related materials, including paper, media, and backup devices.

FAA FOQA Enforcement Policy

The [Airline Name] FOQA Program incorporates the protections codified in the FOQA Rule, part 13, section 13.401, which states that except for deliberate or criminal acts, the Administrator will not use [Airline Name]'s FOQA data or aggregate FOQA data in an enforcement action against [Airline Name] or its employees when such FOQA data or aggregate FOQA data is obtained from a FOQA program that is approved by the Administrator.

Legislation

In the Federal Aviation Reauthorization Act of 1996, Congress included specific provisions pertinent to the public release of safety-related information that was voluntarily submitted to the FAA. Specifically, the Reauthorization Act added a new section—49 U.S.C. § 40123—to the FAA's governing statute to protect voluntarily submitted information from disclosure if the Administrator finds that (1) the disclosure of the information would inhibit the voluntary provision of that type of information and that the receipt of that type of information aids in fulfilling the Administrator's safety and security responsibilities; and (2) withholding such information from disclosure would be consistent with the Administrator's safety and security responsibilities.

The Administrator has issued a rule, 14 CFR part 193, which accomplishes the purposes set forth in this legislation. This rule describes the provisions for designating information that would be protected. Information collected under an FAA-approved voluntary FOQA program has been designated by FAA Order 8000.81 as coming under the provisions of this rule.

6. FOQA PROGRAM COMPONENTS

The principal components that will compose the FOQA program at [Airline Name] are described below and are illustrated in Figure 1.

Aircraft Fleet

The [Aircraft Model/Type] aircraft will be the launch aircraft for the [Airline Name] FOQA program. Twenty of these aircraft will be used to initiate the FOQA program. These aircraft will be equipped with the [Product Name] Flight Data Acquisition Management System on a schedule established by [Airline Name] Maintenance and Engineering. Additional aircraft will be added to the FOQA program pending approval from the FOQA Monitoring Team (FMT) as sufficient experience is gained on data acquisition and analysis.

Airborne Data Acquisition System

[Airline Name] will be utilizing the [Product Name] Quick Access Recorder. This recorder collects continuous flight data parameters and stores this information on the [Specify Storage Media, e.g., PCMCIA card].

Data Download and Airborne System Maintenance and Support

The Flight Data Acquisition Management System and Quick Access Recorder will be maintained per the FAA-approved [Airline Name] aircraft maintenance program. Avionics Engineering will be responsible for managing this process. The [Storage Media] will be downloaded [specify frequency] by means of [Specify Downloading Methodology, e.g., removal and replacement of PCMCIA cards]. The FOQA Manager will be responsible for coordinating maintenance issues with [Airline Name] Avionics Engineering regarding data download and any Flight Data Acquisition Management System problems discovered during data analysis.

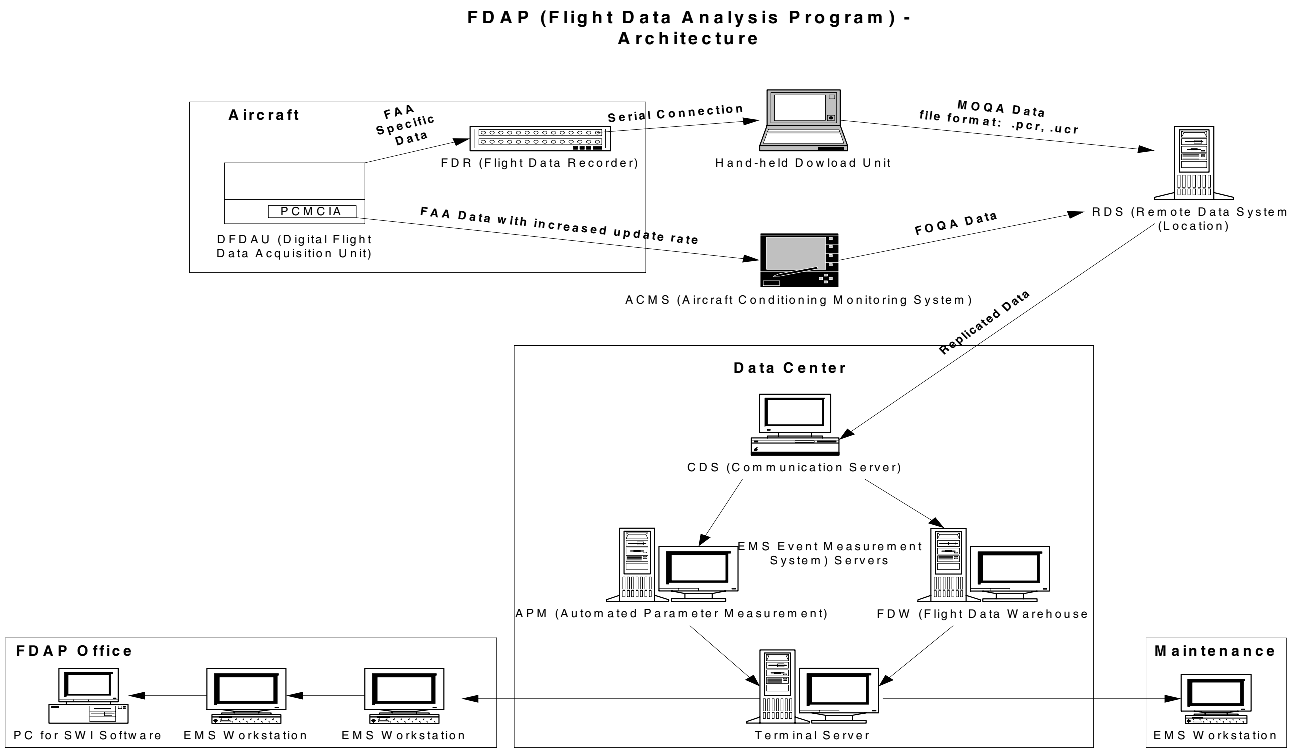
Ground Data Replay and Analysis System (GDRAS)

The GDRAS is designed to process and analyze data from all FOQA-equipped aircraft in the [Airline Name] fleet. It will apply protective mechanisms, including removal of identifying information in accordance with the provisions described in the previous sections. The GDRAS will also include trend analysis capabilities to explore historical data and analyze similar event data from past flights to determine if any patterns exist or if further study is warranted.

Other Equipment

[Airline Name] will be investigating several other components to incorporate into the FOQA program as the technology becomes available and requirements are identified and refined. The addition of these components is subject to approval by the FMT.

FIGURE 1. FOQA SYSTEM ARCHITECTURE



Equipment Upgrade, Modification, or Replacement

The equipment used initially in the FOQA program, including airborne and ground systems, may be upgraded, modified, or replaced with equipment from the same or a different vendor that will provide comparable or superior functionality to the equipment described in this section. Documentation of such changes in airborne or ground systems will be maintained in the FOQA office and will be made available to the FAA on request. This I&O plan will be revised and submitted to the FAA whenever changes to airborne or ground-based systems are made.

7. FOQA ORGANIZATION

Organizational Structure

The [Airline Name] FOQA organization structure is illustrated in Figure 2:

Personnel
The FOQA Program will consist of the following personnel:

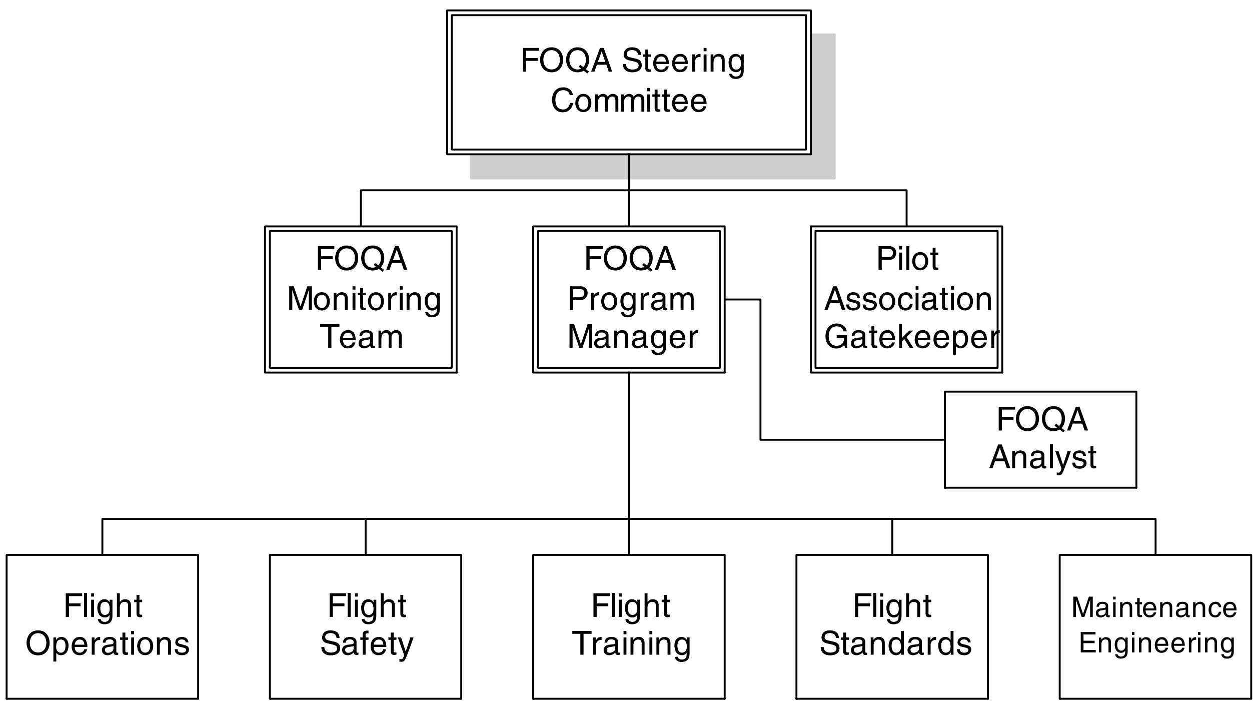
1. **FOQA Steering Committee**
   The FOQA Steering Committee is chaired by the Director of Flight Safety and serves as the advisory group for the FOQA program. Members of this committee include the Vice President of Flight Operations, the Pilot Association Air Safety Chairman, Director of Maintenance, and the Director of Flight Training.

2. **FOQA Program Manager**
   The FOQA Program Manager is responsible for the overall management, administration, security, and maintenance of the FOQA program. These duties include interfacing with the FAA, vendors, and other entities. The program manager's primary duties include addressing the FOQA data needs and reporting requirements of Flight Operations, Training, and Safety departments (and any other stakeholders).

3. **FMT**
   The FMT is chaired by the FOQA Program Manager. The FMT meets once per month to conduct reviews of aggregate trend data to identify recommendations to stakeholders.

4. **FOQA Gatekeeper (s) *[or Pilot Association Gatekeeper(s), if applicable]***
   The FOQA Gatekeeper(s) [*or Pilot Association Gatekeeper(s), if applicable*] will have access to identifying data, *[in accordance with the Pilot Association agreement, if applicable]*. The gatekeeper will manage password selection and maintenance, control access to identifying data, and perform any necessary crew contacts.

FIGURE 2. FOQA ORGANIZATIONAL STRUCTURE



5. FOQA Analyst

The FOQA analyst will assist the FOQA Manager and is responsible for the day-to-day operations of the FOQA GDRAS, generating GDRAS-related reports, and assisting the FMT in reviewing and analyzing data.

8. FOQA PROGRAM IMPLEMENTATION

Program Startup Criteria

The startup criteria for the program will be defined by the FMT and will include, but not be limited to:

- Completion of installation and testing of airborne equipment and GDRAS
- Successful testing of the complete data analysis system
- Validation of flight parameters
- Validation of data collection system from the recording media to the GDRAS
- Implementation of all data de-identification, protection, security, and retention procedures
- Education of pilots and stakeholders
- Training for FOQA team members
- Specification and validation of event and definitions and operational measurements
- Implementation of procedures to detect and analyze triggered events and operational measurements
- Implementation of procedures to identify and track corrective actions

The FMT will make the decision regarding when the established criteria are met. Once the FMT determines a formal start date, any data collected before the formal start date must be re-analyzed prior to retention in the FOQA database in order to assure that all reported events are valid.

FOQA Implementation Schedule

Table 1 below identifies the FOQA implementation schedule, timelines, and milestones.

TABLE 1. FOQA TIMELINE

Month	Task	
Month 1	1.	Coordinate airborne technology requirements, particularly data maps and LFLs, with maintenance/engineering.
	2.	Acquire airborne data acquisition/recording equipment for aircraft.
	3.	Coordinate with maintenance/engineering for installation of equipment in aircraft.
	4.	Evaluate GDRAS products, including on-site system trials.
	5.	Coordinate with corporate information technology personnel for integration

TABLE 1. FOQA TIMELINE		
Month	**Task**	
		with or installation of any communication networks, compliance with computer-related standards, review of vendor maintenance contracts, and any other assistance required.
	6.	Begin education program for company officers and management personnel regarding FOQA benefits.
	7.	Begin periodic FMT meetings to assist in GDRAS evaluation.
	8.	Meet with stakeholders to review current requirements and to define any additional requirements.
	9.	Generate pilot education materials in conjunction with the pilot association.
	10.	Refine program start-up criteria.
Month 2	11.	Convene FMT to review and refine event definitions.
	12.	Continue development of pilot educational materials.
	13.	Develop equipment acceptance criteria with FMT, FOQA Analyst, and associated vendor(s).
	14.	Select and acquire GDRAS hardware, software, and peripherals and coordinate product support and any integration with corporate communications infrastructure.
	15.	Coordinate with vendors and maintenance/engineering to determine procedures and resources required for retrieving airborne data and transferring to FOQA facility.
	16.	Establish interface with maintenance/engineering for addressing FOQA issues.
	17.	Coordinate with GDRAS vendor to define periodic reporting capabilities and formats.
	18.	Refine methods for retrieving data collected on aircraft.
	19.	Refine I&O Plan and submit to AFS-230 and POI for approval.
	20.	Develop and issue maintenance work cards/bulletins for data retrieval procedures.
	21.	Develop methods for tracking receipt and auditing quality of aircraft-recorded data.
	22.	Define data backup, retention, and archiving policies.
	23.	Develop guidelines for crew contact.
Month 3	24.	Acquire/install computer, communications infrastructure, and operating system for GDRAS and other ground and communication equipment.
	25.	Integrate GDRAS with corporate communications infrastructure as appropriate.
	26.	Obtain and attend GDRAS vendor training for FOQA team members.
	27.	Develop and implement security policy and procedures.
	28.	Continue pilot education process.

TABLE 1. FOQA TIMELINE

Month	Task	
	29.	Evaluate GDRAS reporting capabilities using initial data and coordinate with GDRAS vendor to obtain modifications, if required.
	30.	Implement maintenance procedures for routine retrieval of data from aircraft.
	31.	Analyze and validate initial data to confirm proper operation of airborne equipment and GDRAS.
	32.	Establish vendor problem reporting and tracking system for FOQA equipment and software.
Month 4	33.	Formalize and document procedures for event review, evaluation, and follow-up.
	34.	Generate stakeholder education materials.
	35.	Educate POI regarding the specifics of the FOQA program.
	36.	Continue pilot education process.
	37.	Refine and test parameter conversions.
	38.	Refine and test event definitions.
	39.	Review equipment acceptance criteria and resolve outstanding issues with vendors.
	40.	Verify GDRAS and system components compliance with data security and de-identification procedures.
Month 5	41.	Continue development of parameter specifications.
	42.	Continue development of event definitions.
	43.	Define and document procedures for transferring to maintenance/engineering any maintenance-related events captured by FOQA data.
	44.	Continue pilot education process.
	45.	Modify the I&O Plan as appropriate and submit revisions to the FAA.
	46.	Determine and review format for trend and summary reports.
	47.	Establish procedures to validate data and events and in the review and evaluation of trend and summary reports.
	48.	Establish procedures for defining and implementing corrective actions, and tracking their efficacy.
Month 6	49.	Test all aspects of the data collection, transmittal, and analysis system.
	50.	Continue data validation.
	51.	Implement data retention policies.
	52.	Review start-up criteria.
	53.	Implement procedures for system and data back-up and archiving.
	54.	Finalize trend analysis procedures.
	55.	Define schedule and milestones for formal start-up and entry into continuing operations.
	56.	Develop procedures for maintaining I&O plan revisions.
	57.	Implement stakeholder feedback mechanisms.

TABLE 1. FOQA TIMELINE

Month	Task	
	58.	Review FOQA data gathered prior to program's official launch and determine how the data will be used based on the [Airline Name's] data retention policy.
	59.	Continue pilot education process.

9. EDUCATION AND TRAINING

Pilot education about the [Airline Name] FOQA Program will be accomplished through quarterly Flight Operations publications, the Pilot Association publications, and a secure bulletin board at each crew base. These bulletin boards will highlight FOQA issues, including featured events or issues.

Each of the FOQA stakeholders will be provided with information about the FOQA program through reports generated from periodic FOQA meetings, bulletin boards, and an initial FOQA overview report that will be developed and distributed during the initial implementation of the FOQA program.

All FOQA personnel will receive training on the GDRAS software. Additionally, FOQA stakeholders will visit other operators with established FOQA programs. Other training will be provided as new hardware and/or software is added to the program.

10. DATA ANALYSIS PROCEDURES

Data Usage and Management

All processed FOQA data will be maintained by the GDRAS subject to periodic deletion as determined by the FOQA Steering Committee and in accordance with the [Airline Name] record retention policies.

The FMT will be responsible for developing reports summarizing the information obtained through the FOQA Program. The reports will include summaries of the most recent information obtained through the FOQA Program as well as trend information to demonstrate the effectiveness of prior corrective actions. These reports will be distributed to Flight Operations, Flight Training, Flight Safety, Maintenance Engineering, and other involved stakeholders on a regular basis. The FMT will solicit recommendations from the recipients of the reports in order to improve their usefulness as the program proceeds.

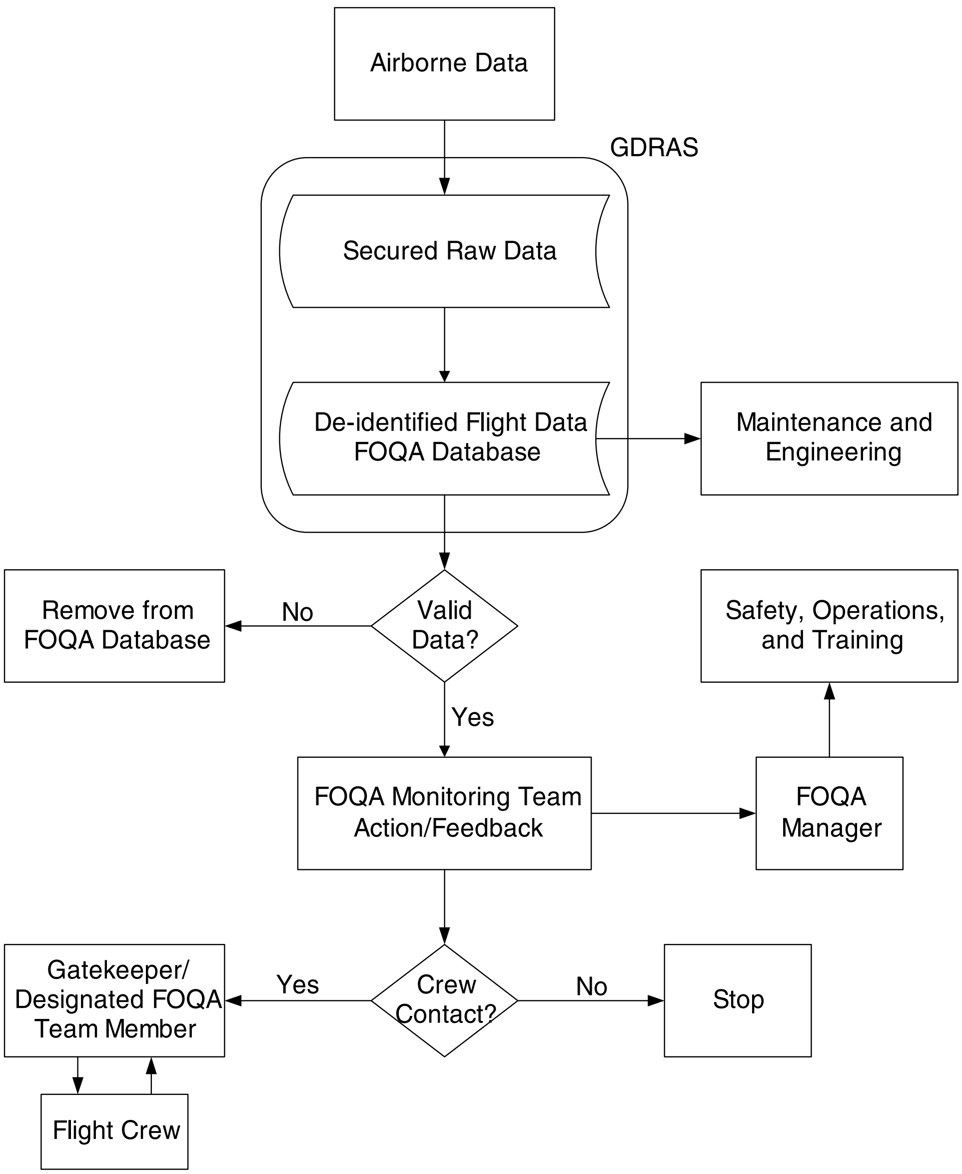
Flight Data Collection and Analysis

The manner in which FOQA data is processed is illustrated in Figure 3. Maintenance Engineering retrieves data from the aircraft and forwards it to the FOQA office. The ground analysis station will process the recorded flight data. Provisions for security and tracking of the media will be established through coordination between the FOQA Program Manager and the Maintenance Engineering.

Flight data will be processed by the FOQA Analyst to determine what occurred and whether the recorded information was legitimate. A preliminary analysis will use the GDRAS to interpret identified events or trends and determine whether the information was valid or invalid because of bad data, a faulty sensor, or some other invalidating factor. In the event that the data reveal a situation of immediate concern to Maintenance Engineering, the FOQA Program Manager will notify that department.

NOTE: Preliminary review of the data to assess validity must be completed within 7 business days from the time the data is received at the FOQA office. After 7 days, the data is permanently de-identified per FMT procedures and the Pilot Association agreement preventing the ability to contact flight crewmembers, if needed. Further analysis of the data received is accomplished in relation to existing aggregate information within the FOQA Program. Program trend reports of the aggregate data are developed by the FMT on a regular basis for presentation to stakeholders for use in developing corrective actions or for monitoring of operational issues.

FIGURE 3. FOQA DATA PROCESSING



Data Classifications and Definitions

Parameters and measurements used in the [Airline Name] FOQA program are contained in Appendix II of this I&O Plan. The definitions will be programmed into the GDRAS to measure events and/or monitor trends. The performance limits that define these definitions will be continually reviewed by the FMT to determine they are consistent with the FOQA program goals, applicable publications, and guidance materials, which may include, but are not limited to, the following:

- Flight Operations Manual (FOM)
- Quick Reference Handbook (QRH)
- [Airline Name] flight training materials
- Approved Flight Manual (AFM)
- Manufacturer Maintenance Manuals

The event set for the [Airline Name] FOQA Program is contained in Appendix II. This event set will be modified as deemed appropriate by the FMT and additional event sets will be defined as needed. The FOQA Program Manager will be responsible for maintaining the event sets and coordinating with the FMT.

Data Definition Maintenance

The procedures for validating, reviewing, and defining event and trend definitions will be established by the FMT and they will determine whether the information is valid and reflects [Airline Name's] qualification and performance standards, training practices, and aircraft performance limits. All changes in the event and trend definitions will be logged and the FOQA Program Manager will maintain the records.

Data Review and Evaluation

All data recorded by the [Airline Name] FOQA Program will be evaluated by the FMT on a periodic basis as determined by the FOQA Program Manager. FOQA data should be evaluated to determine if the program is accurately monitoring collected information for events and trends. The review and evaluation of the measurements, profiles, events, and trends used in the [Airline Name] FOQA Program should reflect changes, updates, or enhancements to policy and procedures within all stakeholders' departments. Consideration should also be given to any changes, updates, or enhancements to policies and procedures within the FAA and industry.

Data Trending and Record Retention

De-identified flight data stored in the GDRAS will be periodically deleted as determined by the FOQA Steering Committee. Trend data will be maintained for a period of time as specified by the FMT in consultation with the FOQA Steering Committee. Maintenance Engineering shall retain the data as long as necessary to satisfy manufacture's warranties.

11. PROGRAM AND DATA DOCUMENTATION

Operational Development

The FOQA Program Manager will develop appropriate documentation for support of the FOQA operation. This documentation will be used to provide routine support for the process and facilitate any personnel transitions that may occur during the program.

Information and Data Control

The FOQA Program Manager will maintain a history of the information used in the FOQA program. When a FOQA or safety issue is identified, a log will be maintained to provide a reference document. This document will provide a way to track how [Airline Name] addresses trends revealed by analysis of the FOQA data. This will include:

- A description of the identified issue
- Analysis that was accomplished
- Specific corrective actions or recommendations taken or made
- Personnel who were notified (e.g., flightcrews [de-identified], Engineering Maintenance, Flight Operations, Flight Training, Flight Safety)
- Resolution of actions or recommendations

The log will be used to generate a summary report for presentation to the FOQA Steering Committee and senior management. This log will be maintained in the FOQA office in a secure place. The FOQA Steering Committee will establish the retention period for this log.

I&O Plan Revision Control

Standard revision control methodology and a distribution list will be established for this I&O Plan. A revision control page that identifies the pages to be added, removed, and/or replaced, will be submitted with any revisions. Each revised page will indicate the page number and date. Revisions to the I&O plan will be provided as necessary and appropriate. All revisions to the I&O plan, including event definitions, will be submitted to the [Airline Name] FAA POI and to FAA AFS-230.

12. FAA ACCESS

The [Airline Name] FAA POI (and/or Aircrew Program Managers [APMs]) and PMI (and/or Partial Program Managers [PPMs]) shall be permitted free and open access to de-identified aggregate FOQA data, including fleet-specific trend analysis information. This review will include a quarterly update of FOQA trend information to [Airline Name]'s FAA personnel. Any FOQA data or information shared with the FAA shall be protected from use by the FAA for enforcement purposes in accordance with14 C.F.R. section 13.401 and shall be protected from public disclosure in accordance with part 193 and FAA Order 8000.81. Any de-identified FOQA data or aggregate FOQA data that leaves [Airline Name]'s property will be clearly labeled as follows: "WARNING: This FOQA information is protected from disclosure under 49

U.S.C. 40123 and 14 CFR part 193. This information may be released only with the written permission of the Federal Aviation Administration Associate Administrator for Regulation and Certification." Airline identity and other information that could be employed to derive airline identity will be removed from any FOQA aggregate data submissions which [Airline Name] provides to the FAA in compliance with section 13.401, unless [Airline Name] elects to include that information. In the event that [Airline Name] chooses to allow FOQA data or aggregate FOQA data that includes airline identity information to be removed from [Airline Name]'s property, all such data will be labeled as the confidential and proprietary property of [Airline Name], in addition to the preceding warning.

In accordance with the FOQA Aviation Rulemaking Committee (ARC) recommendations that have been accepted by the FAA, [Airline Name] will participate in industry information sharing activities for FAA-approved FOQA programs. All information included in any industry sharing activity or any request for information will be reviewed and approved by [Airline Name] before release by [Airline Name]. The information released will be considered [Airline Name] proprietary information and will be de-identified so that specific flight information is not included. To the extent possible, the information released will be de-identified to limit the references that identify it as [Airline Name] information. In addition, at such time as the FAA provides guidance regarding future requirements for compliance with part 13, section 13.401(d), [Airline Name] will review those requirements to determine whether to continue its voluntary participation in an approved FOQA program. If the decision is made to continue with the program, this I&O Plan will be revised accordingly.

APPENDICES

APPENDIX I. PILOT ASSOCIATION AGREEMENT

Insert Pilot Association Agreement (if applicable).

APPENDIX II. EVENT PARAMETERS AND DEFINITIONS

Event Name	Event Description	Parameters and Basic Event Definition	Notes
Excessive Power on the Ground	An event designed to measure high power settings on the ground that could result in injury to personnel or damage to equipment.	Air/Ground Switch, Ground Speed, N_1 Air/Ground = Ground, Ground Speed < x knots, N_1 > x% for x seconds	This event would also be used in the After Landing phase.
Excessive EGT – Start	An event designed to detect EGT in excess of flight manual limits during engine start.	Air/Ground Switch, EGT Air/Ground = Ground, EGT > x degrees for x seconds	This event could be included in other flight phases, if desired, although EGT exceedances other than on engine start are extremely rare.
Engine Overtemp	An event to detect engine EGT in excess of in-flight limits.	EGT EGT > x degree for x seconds	
Takeoff Warning	An event that would trigger on the same conditions that set off the takeoff warning horn.	Air/Ground Switch, Flap Position, Speed Brake Position, Throttle Position (or possibly N_1) Air/Ground = Ground, Flaps < approved takeoff flaps, Flaps > approved takeoff flaps, Speed Brake > 0, Throttle Position > x	On some newer aircraft, Takeoff Warning is a discrete parameter. Trim Setting is normally a component that triggers Takeoff Warning, but it is sometimes not a recorded parameter.

Event Name	Event Description	Parameters and Basic Event Definition	Notes
Rejected Takeoff – Low Speed	An event to detect that the takeoff roll has begun and the takeoff has been abandoned below a pre-determined speed.	CAS, N_1 CAS > x knots, CAS < x knots, N_1 > x% for x seconds, followed by N_1 < x% within 60 seconds	Low end CAS should be greater than any anticipated taxi speed. 100 knots is generally accepted as the cutoff between high- and low-speed aborts.
Rejected Takeoff – High Speed	An event to detect that the takeoff roll has begun and the takeoff has been abandoned above a pre-determined speed.	CAS, Gross Weight, N_1 CAS > x knots, CAS < V_1, N_1 > x% for x seconds, followed by N_1 < x% within 60 seconds	If N_1 is not an available parameter, V_2 or Liftoff Speed may be used as the upper limit.
Liftoff Speed High	An event to determine the relationship of the actual liftoff speed to V_2.	Air/Ground Switch, Gross Weight, CAS Air/Ground = Ground, CAS > V_2 + x knots for x seconds	V_2 is calculated based on Gross Weight.
Liftoff Speed Low	An event to determine the relationship of the actual liftoff speed to V_2.	Air/Ground Switch, Gross Weight, CAS Air Ground = Air, CAS < V_2 – x knots for x seconds	V_2 is calculated based on Gross Weight.
Pitch High at Takeoff	An event that measures pitch at takeoff in relation to the angle required to strike the tail of the aircraft.	Air/Ground Switch, Pitch Air/Ground = Ground, Pitch > x degrees	Limits are based on the angle required for the tail cone to contact the ground with struts compressed.
Takeoff Climb Speed High	An event to detect climb speed higher than desired during the Takeoff Phase of flight.	CAS, Gross Weight, HAT HAT > x feet, HAA < x feet, CAS > V_2 + x knots	Altitude ranges should be used to accommodate different desired climb speeds in those ranges. In certain ranges, the climb airspeed will be based on V_2.

Event Name	Event Description	Parameters and Basic Event Definition	Notes
Takeoff Climb Speed Low	An event to detect climb speed lower than desired during the Takeoff Phase of flight.	CAS, Gross Weight, HAT HAT > x feet, HAA < x feet, CAS < V_2 – x knots	Altitude ranges should be used to accommodate different desired climb speeds in those ranges.
Early Flap Retraction	An event to detect any flap movement from the takeoff position prior to reaching the altitude at which flap retraction should begin.	HAT, Flap Position HAT< x feet, Flap Position < Flap Position in the preceding sample	
Excessive Bank Angle at Takeoff	An event to detect when the bank angle exceeds the maximum allowable bank angle.	HAT, Roll HAT > x feet, HAT < x feet, Roll > x degrees for x seconds	Altitude ranges should subdivide this event with different bank limitations in each range.
Turbulence – Flaps Extended	An event to detect excessive G-forces prior to flap retraction.	Vertical Acceleration, Flap Position Flaps > 0, Vertical Acceleration > x g for x seconds	1.5 g is a generally accepted limit for this type of event. This event can also occur during the Approach phase of flight.
Slow Initial Climb	An event to detect a slower than normal climb to the clean-up altitude.	Air/Ground Switch, HAT Time > x seconds from Air/ Ground = Air to HAT = x feet	HAT would be based on clean-up altitude.
Abnormal Flap Retraction	An event to detect slow flap movement between any selected flap position and the previously selected flap position.	Flap Position, Flap Handle Position Time from Flap Handle Position = x degrees until Flap Position = x degrees > x seconds	This event will also detect stuck flaps.

Event Name	Event Description	Parameters and Basic Event Definition	Notes
Height Loss in Climb	An event to detect an interruption in climb in which altitude is lost before the climb resumes.	HAT HAT < than x feet, HAT < HAT in preceding sample	This event might benefit from subdivision in altitude ranges.
Climb Speed High	An event to detect climb speed higher than 250 knots below 10,000 feet.	Altitude, CAS Altitude < 10,000 feet, CAS > 250 knots for x seconds	
Flap Limit Altitude	An event to detect when flaps are operated above the maximum allowable altitude for flap operation.	Altitude, Flaps Position Altitude > x feet, Flap Position > 0 degrees	Altitude would correspond to the maximum operating altitude for flaps extended.
Turbulence – Flaps Up	An event to detect excessive G-force while airborne, indicating an encounter with turbulent conditions.	Air/Ground Switch, Vertical Acceleration Air/Ground = Air, Vertical Acceleration > x g, Vertical Acceleration > -x g	This event will measure turbulence from all sources (convective activity, clear air, or wake induced). Vertical Acceleration limits of +1.5 g to – 0.5 g might be considered.
Holding/ Excess Radar Vectoring	An event to detect excessive delays caused by ATC holding/radar vectoring.	Heading Cumulative Time > x, Heading = Heading + 359 degrees, Time < 600 seconds	The start point for this event would occur after the first 360-degree turn and end 600 seconds after the last turn. The event would trigger when the cumulative time exceeds a user-defined value.

Event Name	Event Description	Parameters and Basic Event Definition	Notes
Operating Ceiling Exceeded	An event to detect operation of the aircraft above its certificated maximum operating altitude.	Altitude Altitude > x feet for x seconds	
Landing Gear Down Speed Exceeded (Mach)	The indicated mach number of the aircraft exceeds the maximum allowable mach for operation with the landing gear in the down position.	Mach, Landing Gear Position Landing Gear Position = Down, Mach > x mach number for x seconds	Limiting mach number would be $M_{LE.}$
M_{MO} Exceeded	An event to detect occurrences of the indicated mach number of the aircraft in excess of the maximum allowable mach number.	Mach Mach > x mach number for x seconds	
V_{MO} Exceeded	An event to detect occurrences of the indicated airspeed of the aircraft in excess of the maximum allowable airspeed.	CAS CAS > x knots for x seconds	
High Descent Rate	An event that measures unusually high rates of descent.	Inertial Vertical Speed, HAT, Altitude Descent rate > x fpm for x seconds, HAT/Altitude > x, HAT/Altitude < x	This event can be subdivided into altitude ranges to capture abnormal rates of descent that might be caused by different ATC facilities.
Excessive Speedbrake Usage	An event that measures the amount of time the speedbrake is used during descent.	Speed Brake Handle, Air/Ground Switch Air/Ground = Air, Cumulative Time Speed Brake > 0	This event is useful in evaluating arrival procedures into specific airports.

Event Name	Event Description	Parameters and Basic Event Definition	Notes
Approach Speed High	An event to detect operation on approach that is in excess of its computed final approach speed.	Gross Weight, CAS, HAT, Flaps HAT > 1,000 feet, HAT < 3,000 feet, CAS > V_{FE} – x knots HAT < 1,000 feet, CAS > V_{REF} + x knots	This event should be broken down into altitude bands. Suggested breakdown would be HAT > 1,000 feet, HAT 500 – 1,000 feet, HAT 50 – 500 feet, HAT < 50 feet. Speeds above 1,000 feet would reference a lookup table.
Approach Speed Low	An event to detect operation on approach that is below its computed final approach speed.	Gross Weight, CAS, HAT HAT > 1,000 feet, CAS < flap maneuvering speed – x knots HAT < 1,000 feet, CAS < V_{REF} – x knots	Speeds above 1,000 feet would reference a lookup table.
Excessive Power Increase	An event to detect an excessive power increase during final phase of approach.	HAT, N_1 Δ of N_1 at 500 feet and N_1 < 500 feet > x	
Abnormal Configuration – Flaps/Speedbrake	An event to detect the simultaneous use of flaps and speedbrakes.	Speedbrake Handle, Flaps Speedbrake handle > 0, flaps > 0	This event would only be included if this type of operation were prohibited in the flight operations manual.
Abnormal Flap Extension	An event to detect slow flap movement between any selected flap position and the previously selected flap position.	Flap Position, Flap Handle Position Time from Flap Handle Position = x degrees until Flap Position = x degrees > x seconds	This event will also detect stuck flaps.

Event Name	Event Description	Parameters and Basic Event Definition	Notes
Landing Gear Down Speed Exceeded (IAS)	An event to detect when the indicated airspeed of the aircraft exceeds the maximum allowable airspeed for operation with the landing gear in the down position.	Landing Gear Position, CAS Landing Gear = Down, CAS > x knots	
Late Landing Flaps	An event to detect flap movement to the landing flap position below a pre-determined altitude.	HAT, Flap Handle Position, Air/Ground Switch Air/Ground = Air, HAT < x feet, Flap Handle Position at x feet HAT < Flap Handle Position at touchdown	This event is slightly different from Late Landing Configuration in that it detects flap movement below a set altitude rather than a flap setting.
Low Power on Approach	An event to detect aircraft engines not spooled or the power reduced to an unspooled condition below a predetermined altitude.	Air/Ground Switch, HAT, N_1 Air/Ground = Air, HAT < x feet, N_1 < x %	
Landing Gear Operation	An event to detect when the indicated airspeed of the aircraft exceeds the maximum allowable airspeed for operation of the landing gear in transit.	Landing Gear Warning, CAS Landing Gear Warning (in transit) = On, CAS > x knots	If the operating limitation is different for landing gear extension and retraction, separate events will need to be created for each limitation.
Operation Left of Localizer Centerline	An event to detect deviation left of localizer centerline.	Localizer Deviation Left, HAT Localizer Deviation > x dots, HAT > x feet	
Operation Right of Localizer Centerline	An event to detect deviation right of localizer centerline.	Localizer Deviation Right, HAT Localizer Deviation > x dots, HAT > x feet	

Event Name	Event Description	Parameters and Basic Event Definition	Notes
Operation Above Glideslope	An event to detect deviation above glideslope.	Glide Slope Deviation High, HAT Glide Slope > x dots, HAT < x feet	
Operation Below Glideslope	An event to detect deviation below glideslope.	Glide Slope Deviation Low, HAT Glide Slope > x dots, HAT < x feet	
Descent Below MDA	An event to detect descent below MDA (followed by a climb back to MDA) on non-precision approaches.	HAT, Altitude HAT < 1,000 feet, Altitude > Altitude in preceding sample + x feet	
Flap Limiting Speed	An event to detect flap operation at a speed that exceeds the maximum placarded airspeed.	Flap Position, CAS Flap Position = x, CAS > x knots for x seconds	This event will be constructed with a different speed limit for each flap setting through the use of a lookup table. It will also detect speed exceedances during retraction in the Takeoff phase of flight.
Go Around	An event to detect that the aircraft has begun its descent for landing, discontinues that descent, and does not land from that approach.	HAT, Altitude, N_1 HAT < 2,000 feet, HAT > 1 foot, Altitude < preceding Altitude sample for 10 seconds, N_1 > 98%, Altitude > any preceding Altitude sample in previous 60 seconds + 300 feet	

Event Name	Event Description	Parameters and Basic Event Definition	Notes
ATC Go Around	An event to detect a go-around event in which no other events are triggered, such as approach instability, indicating the go around was directed by ATC.	HAT, Altitude, N_1, Localizer Deviation, Glide Slope Deviation, CAS HAT < 2,000 feet, HAT > 1 foot, N1 > 98%, Altitude > any preceding Altitude sample in previous 60 seconds + 300 feet, Localizer Deviation < x dots, Glide Slope Deviation < x dots, CAS = V_{REF} ± x knots	
Late Landing Configuration	An event to detect that the aircraft is not configured with landing flaps and landing gear in the down and locked position at 500 feet HAT.	HAT, Landing Gear Position, Flap Position HAT < 500 feet, Landing Gear Warning = On, Flap Position < x flaps	
Tire Limiting Speed	An event to detect if the tire limiting speed is exceeded.	Air/Ground Switch, CAS Air/Ground = Ground, CAS > x knots	
Pitch High – Landing	An event that measures pitch at landing in relation to the angle required to strike the tail of the aircraft.	Air/Ground Switch, Pitch Air/Ground = Ground, Pitch > x degrees from 6 seconds before to 15 seconds after touchdown	Limits are based on the angle required for the tail cone to contact the ground with struts compressed.
Pitch Low – Landing	An event that measures pitch attitude where the aircraft is in a nose down attitude that might result in an initial nose-gear touchdown or three-point landing.	Air/Ground Switch, Pitch Air Ground = Ground, Pitch < x degrees from 3 seconds before to 1 second after touchdown	

Event Name	Event Description	Parameters and Basic Event Definition	Notes
Landing in a Crab	An event to detect failure to align aircraft with the runway at touchdown.	Heading, CAS Δ Heading at Touchdown vs. Average Heading until CAS = 60 knots	
Hard Landing	An event that measures excessive G-force at touchdown, indicating a hard landing.	Air/Ground Switch, Vertical Acceleration Air/Ground = Ground, Vertical Acceleration > x G	
Bounced Landing	An event that measures excessive G-force at touchdown followed by a second excessive G-force, indicating a bounced, hard landing.	Air Ground Switch, Vertical Acceleration Air/Ground = Ground, Vertical Acceleration > x G, followed by second Vertical Acceleration > x G within 20 seconds of first touchdown	
Excessive Brake Usage	An event to detect higher-than-normal brake application.	Brake Pressure Sum of Brake Pressure readings (one per second) from Touchdown to Runway Turnoff/1000. Resulting index number > x	A routine operational measurement (ROM) would be helpful to determine normal braking at a given airport.
Thrust Reverser Stowed	An event that measures the speed at which the thrust reverser is stowed during landing rollout.	CAS, Thrust Reverser Deploy Thrust Reverser = On for 5 seconds before Thrust Reverser = Off, CAS > x knots	
Overweight Landing	An event to detect landings made in excess of the maximum gross landing weight.	Air/Ground Switch, Gross Weight Air/Ground from Air to Ground + 20 seconds, Gross weight > x pounds	

Event Name	Event Description	Parameters and Basic Event Definition	Notes
Abnormal/ Incorrect Landing Flaps	An event to detect that the aircraft touched down with flaps in a position less than the minimum expected landing flap setting.	Air/Ground Switch, Flap Position, Air/Ground from Air to Ground + 5 seconds, Flaps < x degrees	Will need to be customized for the recommendations in the flight manual.
Runway/Taxi way Rough	An event that measures excessive G-force on the ground, indicating defects in runway/taxiway surfaces.	Air/Ground Switch, Vertical Acceleration, CAS Air/Ground = Ground, CAS < 100 knots, Vertical Acceleration >1.3 g	
Stick Shaker Operation	An event to detect stick shaker operation.	Stick Shaker Stick Shaker + On (L or R)	
GPWS Warning	An event to detect when a GPWS warning is triggered.	GPWS GPWS = On	This event should be subdivided for each of the different warning modes of the GPWS.
Engine Failure	An event to detect in-flight engine failure/shutdown.	Air/Ground Switch, Fuel Flow, Oil Pressure, EGT Air/Ground = Air, Oil Pressure < x psi, Fuel Flow < x pph, EGT < x degrees	
TCAS Advisory	An event to detect any TCAS advisory triggered.	TCAS Advisory (Up or Down) TCAS Advisory = On	This event should be separated for TCAS Traffic Advisories (TAs) and Resolution Advisories (RAs).
Engine Reverse at Low Speed	An event to detect use of engine reverse at low speed that can result in engine overtemps and/or FOD ingestion.	Thrust Reverser, N_1, CAS Thrust Reverser = On, CAS < x knots, N_1 > x% for x seconds	

APPENDIX III. GLOSSARY

GLOSSARY	
Term	**Definition**
ACARS	Aircraft Communications Addressing and Reporting System. ACARS is a VHF air/ground data link that uses nearly 600 VHF frequency locations throughout North and Central America, Hawaii, the Caribbean, and several U.S. territories. It relays Aircraft Operational Control (AOC), Airline Administrative Control (AAC), and Air Traffic Control (ATC) messages between ground-based organizations and the cockpit.
ACMS	Aircraft Condition Monitoring System. An airborne unit that can create reports such as long-term trend data and aircraft/engine monitoring. ACMS is mainly used for maintenance applications.
Aggregate Data	Detailed data grouped according to some criterion and combined using mathematical or statistical methods (e.g., sum, count, average, standard deviation).
Air Carrier	An organization that undertakes -- either directly or by lease or some other arrangement -- to engage in air transportation.
ARINC	Aeronautical Radio Incorporated. The ARINC organization is the technical, publishing, and administrative support arm of the Airlines Electronic Engineering Committee (AEEC) groups. AEEC standards define avionics form, fit, function, and interfaces.
ATC	Air Traffic Control. A service operated by appropriate authority to promote the safe, orderly, and expeditious flow of air traffic.
COTS	Commercial-Off-the-Shelf. Products, components, or software that are readily available through normal commercial channels, as opposed to custom-built units that would achieve the same functionality.
DAR	Digital ACMS Recorder. See ACMS.
Data Frame	A data map. See LFL.
De-identified Data	Data from which any identifying element that could be used to associate them with a particular flight, date, or flightcrew has been removed.

GLOSSARY	
Term	**Definition**
DFDAU	Digital Flight Data Acquisition Unit. A device that acquires aircraft data via a digital data bus and analog inputs, and formats that information for output to the flight data recorder in accordance with requirements of regulatory agencies. In addition to the mandatory functions, many DFDAUs have a second processor and memory module that enables them to perform additional Aircraft Condition Monitoring System (ACMS) functions/reports. The DFDAU can provide data and pre-defined reports to the cockpit printer, or a display for the flightcrew, or directly to Aircraft Communications Addressing and Reporting System (ACARS) for transmittal to a ground station, or to a Quick Access Recorder (QAR) for recording/storage of raw flight data.
DFDMU	Digital Flight Data Management Unit. A unit that performs the same data conversion functions as the DFDAU and has the added capability to process data onboard the aircraft. Additionally, this unit has a powerful data processor designed to perform in-flight airframe/engine and flight performance monitoring and analysis. Some DFDMUs have ground data link and ground collision avoidance systems incorporated into the units.
DFDR	Digital Flight Data Recorder. A digital device that records pertinent parameters and technical information about a flight. At a minimum, it records those parameters required by the governing regulatory agency, but may record a much higher number of parameters. A DFDR is designed to withstand the forces of a crash so that information recorded by it may be used to reconstruct the circumstances leading up to the accident.
DMU	Data Management Unit. A unit that performs the same data conversion functions as a Flight Data Acquisition Unit (FDAU) with the added capability to process data onboard the aircraft. Additionally, this unit has a powerful data processor designed to perform in-flight airframe/engine and flight performance monitoring and analysis. Some DMUs have ground data link and ground collision avoidance systems incorporated into the unit.
EGT	Exceedance Guidance Team. See FMT.
EMT	Event Monitoring Team. See FMT.
Event	An occurrence or condition in which pre-determined limits of aircraft parameters have been exceeded. Events represent the conditions to be tracked and monitored during various phases of flight and are based on sensory data parameters available on a specific aircraft fleet. Events may be categorized at different severity levels based on the degree to which the associated limits were exceeded. Most FOQA trend analysis is based on event monitoring and tracking.

GLOSSARY	
Term	**Definition**
Event Set	A collection of events designed to measure all aspects of normal flight operations for a particular aircraft type at a particular air carrier. Individual events within the event set would be customized to the approved limitations for the aircraft type and in accordance with the air carrier's operational procedures. The event set for a particular fleet may be limited by the available parameters on the aircraft.
FAR	Federal Aviation Regulations. Federal rules that govern airworthiness and the conduct of flight operations by certificate holders, among other safety matters.
FDAU	Flight data acquisition unit. See DFDAU.
FDR	Flight data recorder. A required device that records pertinent parameters and technical information about a flight. At a minimum, it records those parameters required by the governing regulatory agency, but may record a much higher number of parameters. An FDR is designed to withstand the forces of a crash so that information recorded by it may be used to reconstruct the circumstances leading up to the accident. See DFDR.
FMT	FMT. A group comprised of representatives from the pilot association, if applicable, and the air carrier. This group, sometimes referred to as the Exceedance Guidance Team (EGT) or Event Monitoring Team (EMT), is responsible for reviewing and analyzing flight and event data, and determining and monitoring corrective actions.
FOQA	Flight Operational Quality Assurance. A voluntary program for the routine collection and analysis of flight operational data to provide more information about, and greater insight into, the total flight operations environment. A FOQA program combines these data with other sources and operational experience to develop objective information to enhance safety, training effectiveness, operational procedures, maintenance and engineering procedures, and air traffic control procedures.
Gatekeeper	The FOQA team member who is primarily responsible for the security of identified data. The gatekeeper is the only individual who can link FOQA data to an individual flight or crewmember. The gatekeeper is normally a member of the pilot association.
GDL	Ground Data Link. See WDL.
GDRAS	Ground Data Replay and Analysis System. A software application designed to: transform airborne recorded data into a usable form for analysis; process and scan selected flight data parameters; compare recorded or calculated values to predetermined norms using event algorithms; and generate exceedance reports for review or trending when exceedances are found.

GLOSSARY	
Term	**Definition**
I&O Plan	Implementation and Operations Plan. A detailed specification of key aspects of a FOQA program to be implemented by an air carrier, including a description of the operator's plan for collecting and analyzing the data, procedures for taking corrective action that analysis of the data indicates is necessary in the interest of safety, procedures for providing the FAA with de-identified aggregate FOQA information, and procedures for informing the FAA as to any corrective actions being undertaken.
LAN	Local Area Network. A communications network that serves users within a confined geographical area, typically linked together by cable.
LFL	Logical Frame Layout. A data map that describes the format in which parameter data are transcribed to a recording device. This document details where each bit of data is stored.
LRU	Line Replaceable Unit. A unit that can be replaced by line maintenance personnel without removing the aircraft from service for an extended period.
Mapping	See LFL.
MEL	Minimum Equipment List. A list of required equipment that, under certain conditions, might be inoperative.
MTBF	Mean Time Between Failure. The life expectancy of a component or part, expressed in flight hours.
OQAR	Optical Quick Access Recorder. See QAR. A QAR that stores data on an optical disk.
PAI	Principal Avionics Inspector. The FAA employee responsible for oversight and inspection of avionics at a specific air carrier.
Parameters	Measurable variables that supply information about the status of an aircraft system or subsystem, position, or operating environment. Parameters are collected by a data acquisition unit installed on the aircraft and then sent to analysis and reporting systems.
PCMCIA card	Personal Computer Memory Card International Association card. A credit card-sized data storage and transfer device that was originally developed for portable computers and may be used on some QARs. The Personal Computer Memory Card International Association was organized in 1989 to promote standards for these memory or input/output (I/O) devices.
PMI	Principal Maintenance Inspector. The FAA employee responsible for oversight and inspection of aircraft maintenance functions at a specific air carrier.
POI	Principal Operations Inspector. The FAA employee responsible for operational oversight of a specific air carrier.

GLOSSARY	
Term	**Definition**
QAR	Quick Access Recorder. A recording unit onboard the aircraft that stores flight-recorded data. These units are designed to provide quick and easy access to a removable medium, such as an optical disk or PCMCIA card, on which flight information is recorded. QARs may also store data in solid-state memory that is accessed through a download reader. QARs have now been developed to record an expanded data frame, sometimes supporting 2,000 plus parameters at much higher sample rates than the FDR. The expanded data frame greatly increases the resolution and accuracy of the ground analysis programs.
SRU	Shop Replaceable Unit. A unit that must normally be replaced in a maintenance facility during heavy maintenance checks.
SSFDR	Solid State DFDR. A DFDR that utilizes solid-state memory for recording flight data. See DFDR.
STC	Supplemental Type Certificate. An addendum to the Type Certificate. An STC is required for any new equipment installed on a model of aircraft after that model of airplane has been issued a Type Certificate. See TC.
TC	Type Certificate. The initial certificate issued for every new model of aircraft. The TC lists components and equipment installed on that model of aircraft.
WAN	Wide Area Network. A communications network in which computers are connected to each other over a long distance, using telephone lines, cable connections, or satellite links.
WDL	Wireless Data Link. A system allowing the high-speed transfer of onboard aircraft data to ground facilities using various wireless technologies. It may also allow for upload of data to the aircraft. Sometimes referred to as Ground Data Link (GDL).

APPENDIX IV. REFERENCES

CFR Part 193, Protection of Voluntarily Submitted Information
CFR Part 13, Section 13.401, Flight Operational Quality Assurance Program
AC 00-46, as amended, Aviation Safety Reporting System (ASRS)
AC 00-58, as amended, Voluntary Disclosure Reporting Program
AC 120-59, as amended, Air Carrier Internal Evaluation Programs: Air Carrier Internal Evaluation-Model Program Guide
AC 120-66, as amended, Aviation Safety Action Program
Flight Safety Foundation, FAA Contract Report, Air Carrier Voluntary Flight Operational Quality Assurance (FOQA) Program, 1992
General Accounting Office, GAO/RCED-98-10, Aviation Safety—Efforts to Implement Flight Operational Quality Assurance Programs, December 1997

APPENDIX B. FOQA I&O PLAN CHECKLIST

The following checklist should be used by certificate holders to prepare their I&O Plans and verify that all required materials are included. The FAA will review this checklist to determine that the items required in a FOQA program have been specified in the I&O Plan. This checklist identifies the minimum requirements of an I&O Plan. An air carrier's I&O Plan may contain additional information in excess of these minimum requirements. When the I&O Plan is submitted for FAA approval, a completed copy of this checklist should accompany it.
The "Response" column must be completed for each question. Appropriate responses are "Yes," "No," or "NA" (not applicable). All "No" and "NA" responses should include, in the "Comment" column, a brief explanation of each such response.

The "Reference" column is to be completed for each question to which the air carrier provides a "Yes" response. The information provided in the "Reference" column must identify the specific location of the subject item in the I&O Plan (e.g., Section 2.1).

I&O Plan Checklist			
	Response	**Reference**	**Comment**
General			
1. Has approval of the I&O Plan been requested by the certificate holder in a cover letter addressed to the POI, accompanying submittal of the plan?	❑ Yes ❑ No ❑ NA		
2. Has a copy of the cover letter and plan been forwarded to HQ FAA/AFS-230?	❑ Yes ❑ No ❑ NA		
3. Does the I&O Plan identify the personnel, system equipment, and resources that have been committed to support of the FOQA program?	❑ Yes ❑ No ❑ NA		
4. Does the I&O Plan acknowledge that revisions will be documented in accordance with standard revision control methodology?	❑ Yes ❑ No ❑ NA		
5. Does the I&O Plan acknowledge that, following initial FAA approval, subsequent modifications to the FOQA program must be documented in revisions submitted to the POI and AFS-230?	❑ Yes ❑ No ❑ NA		

I&O Plan Checklist			
	Response	**Reference**	**Comment**
I&O Plan			
1. Have the goals and objectives of the FOQA program been clearly specified?	❑ Yes ❑ No ❑ NA		
2. Have the major stakeholders within the air carrier been clearly identified?	❑ Yes ❑ No ❑ NA		
3. Has a copy of an agreement with the pilot association (if applicable) for FOQA data usage been included as an appendix?	❑ Yes ❑ No ❑ NA		
4. Are air carrier data safeguard and protection mechanisms described?	❑ Yes ❑ No ❑ NA		
5. Are the air carrier fleets (make, model, series) that are targeted for participation in the FOQA program identified?	❑ Yes ❑ No ❑ NA		
6. Are the capabilities of the planned airborne equipment for FOQA described?	❑ Yes ❑ No ❑ NA		
7. Does the plan identify provisions for airborne equipment maintenance and support?	❑ Yes ❑ No ❑ NA		

I&O Plan Checklist			
	Response	**Reference**	**Comment**
8. Is a fleet installation plan specified?	❑ Yes ❑ No ❑ NA		
9. Are the capabilities of the proposed ground data replay and analysis system (GDRAS) described?	❑ Yes ❑ No ❑ NA		
10. Does the plan identify provisions for maintenance of the GDRAS hardware and software?	❑ Yes ❑ No ❑ NA		
11. Does the plan describe other key technology components of the air carrier's FOQA program?	❑ Yes ❑ No ❑ NA		
12. Has a single point of contact been designated to oversee the FOQA program?	❑ Yes ❑ No ❑ NA		
13. Does the plan define the air carrier's organizational structure for oversight and operation of the FOQA program?	❑ Yes ❑ No ❑ NA		
14. Does the plan describe the roles and responsibilities of key air carrier personnel and teams?	❑ Yes ❑ No ❑ NA		

I&O Plan Checklist			
	Response	**Reference**	**Comment**
15. Does the plan specify the schedule and timeline for implementing the FOQA program?	❑ Yes ❑ No ❑ NA		
16. Are FOQA program start-up criteria specified?	❑ Yes ❑ No ❑ NA		
17. Does the plan describe how key FOQA team members will be trained?	❑ Yes ❑ No ❑ NA		
18. Does the plan describe how the air carrier will educate its pilots about the FOQA program?	❑ Yes ❑ No ❑ NA		
19. Is a plan for educating senior management and stakeholders described?	❑ Yes ❑ No ❑ NA		
20. Does the I&O Plan specify procedures for implementing and auditing security mechanisms?	❑ Yes ❑ No ❑ NA		
21. Is a data storage and retention policy specified?	❑ Yes ❑ No ❑ NA		
22. Are flight data collection and retrieval procedures specified?	❑ Yes ❑ No ❑ NA		
23. Are the procedures for defining fleet-specific events and associated parameters described?	❑ Yes ❑ No ❑ NA		

I&O Plan Checklist			
	Response	**Reference**	**Comment**
24. Are the fleet-specific event definitions, including trigger limits for each event's severity classification, provided as Appendix 2 to the plan?	❑ Yes ❑ No ❑ NA		
25. Are the procedures for validating, refining, and tracking event definitions described?	❑ Yes ❑ No ❑ NA		
26. Does the plan acknowledge that updates to FOQA event definitions must be included in I&O Plan revisions submitted to the FAA?	❑ Yes ❑ No ❑ NA		
27. Are procedures for data review and evaluation specified?	❑ Yes ❑ No ❑ NA		
28. Does the plan provide for notifying appropriate air carrier departments of adverse trends revealed by FOQA data flightcrew training?	❑ Yes ❑ No ❑ NA		
29. Are procedures for taking, tracking, and following up on corrective actions specified?	❑ Yes ❑ No ❑ NA		

I&O Plan Checklist			
	Response	**Reference**	**Comment**
30. Are guidelines for crewmember contact and follow-up described?	❑ Yes ❑ No ❑ NA		
31. Is a description included of how FOQA system procedures will be documented?	❑ Yes ❑ No ❑ NA		
32. Does the plan describe the process for joint FAA/air carrier periodic reviews of the FOQA program and associated aggregate data?	❑ Yes ❑ No ❑ NA		

Radio Procedures Most Common Factor in Airspace-related Occurrences in Australian MBZs

A study of reported airspace-related occurrences during the 1994–2001 period, involving regular public transport aircraft and charter aircraft within mandatory broadcast zones (MBZs), found that the occurrence rate increased significantly. The report said, however, that the increase probably was related to an improved reporting climate.

— FSF EDITORIAL STAFF

Australian airspace includes 85 mandatory broadcast zones (MBZs), uncontrolled airspace in which aircraft are required to carry an operational very-high-frequency (VHF) radio, and in which pilots are required to make specified radio broadcasts to facilitate separation between aircraft. "The adequacy of MBZ procedures to ensure the safety of instrument flight rules (IFR) [aircraft], regular public transport (RPT) [aircraft] and charter aircraft has been questioned several times since their inception in 1991," said a report by the Australian Transport Safety Bureau.

The report, based on a study of airspace-related occurrences[1] in MBZs during calendar years 1994 through 2001, said that "the available data indicate that within MBZs, airspace-related occurrences are reported at between one [per week] and two per week, with a relatively large proportion of these occurrences being reported by the RPT sector. … The rate of total reported occurrences in MBZs has increased significantly over the period studied."

The report said, however, that the proportion of occurrences involving RPT aircraft probably was related to more-active reporting behavior by the RPT sector, and that the rising rate of reported occurrences probably could be ascribed to "an improving reporting culture within the Australian aviation industry" rather than to an actual increase in the occurrence rate.

The study found that the percentage of reported airspace-related occurrences in MBZs that resulted in airmisses[2]

The rising rate of reported occurrences probably could be ascribed to "an improving reporting culture within the Australian aviation industry."

did not change significantly during the 1994–2001 period.

"It appears that 'nonperformance of radio procedures' within MBZs is by far the most common factor contributing to airspace-related occurrences reported to the ATSB," said the report.

ATSB was concerned primarily with the safety of fare-paying passengers, the report said, and therefore focused on conflicts involving RPT operations and charter operations.

An MBZ encompasses the airspace surrounding a designated uncontrolled airport. An MBZ also can exist at an airport when air traffic control (ATC) services are not in operation. The standard area of an MBZ includes a radius of 15 nautical miles (28 kilometers) from the airport, and from the surface to 15,000 feet above ground level, unless otherwise specified.

"The primary reason that the airspace surrounding an [airport] would be designated as [an] MBZ is a high level of total movements, particularly those involving the Saab [340], [de Havilland] Dash-8 and [Fairchild] Metro, but may also include larger jet aircraft such as the [British Aerospace (now BAE Systems)] BAe 146 and [Boeing] 737," said the report. Other aircraft involved in MBZ occurrences summarized in an appendix to the report included the Shorts 360, the Lockheed Martin C-130, the British Aerospace (now BAE Systems) Jetstream 31, the Airbus A320, the Raytheon Beech Baron 58 and the Fokker F28.

Pilots of aircraft operating in an MBZ are required to make at least four radio broadcasts:

- Inbound at (or before) 15 nautical miles from the airport;
- Joining the airport traffic pattern or when beginning a straight-in final approach;
- Taxiing prior to departure or entering the runway; and,
- Lining up for or rolling for takeoff.

"These calls typically include an 'all stations' alert, the name of the MBZ being operated in [and] the aircraft registration, location and intentions," said the report. "Responses to these calls are only required for an inbound or taxiing call, or when a potential conflict exists. The purpose of these mandated broadcasts is to allow pilots to arrange mutual traffic separation."

The study used data reported to ATSB that were recorded in the Occurrence Analysis and Safety Investigation System (OASIS). The database was searched for all airspace-related occurrences that took place in a mandatory traffic advisory frequency (MTAF)[3] area or MBZ during 1994 through 2001. Two ATSB senior transport safety investigators reviewed the OASIS files to determine whether the occurrences involved an airspace issue. "Incidents were included in the analysis if they were considered to be airspace requirement[–based], judgment[-based] or procedural-based, rather than mechanical-based," said the report.

The research of the OASIS records identified a total of 573 airspace-related occurrences in MBZs during the study period. There were no accidents within MBZs where an airspace-related issue was found to be a contributing factor. The total number of occurrences, occurrences involving RPT aircraft and occurrences involving charter aircraft in MBZs, by year, are shown in Table 1.

The 290 total RPT occurrences and 63 total charter occurrences in MBZs, the report said, are "of potential concern given the high volume of fare-paying passengers traveling in these areas. It can be seen that RPT aircraft are involved in approximately half of all reported occurrences in MBZs. Charter aircraft are involved in 11 percent of airspace-related occurrences."

Although the numbers show an upward trend during the study period, the report said that RPT occurrences (not necessarily airspace-related or in MBZs) reported during the study period had risen similarly. Therefore, it said, the upward trend in numbers of airspace-related RPT occurrences in MBZs "is not specific to airspace-related occurrences within Australian airspace." Further, the report said, the trend might reflect the increased use of the traffic-alert and collision avoidance system (TCAS), which enabled RPT

Table 1
Airspace-related Occurrences in Australian MBZs, by Year

	1994	1995	1996	1997	1998	1999	2000	2001	Total
Total MBZ Occurrences	42	54	44	91	77	73	106	86	**573**
RPT Occurrences	11	30	14	48	46	43	50	48	**290**
Charter Occurrences	6	11	4	8	8	8	12	6	**63**

MBZ = Mandatory broadcast zone RPT = Regular public transport

Source: Australian Transport Safety Bureau pilots in particular to identify and report occurrences that otherwise might have gone unnoticed.

The study also was designed to determine trends in the rate of airspace-related occurrences in MBZs. Data for aircraft movements or hours flown within MBZs were not available; therefore, the study used as a proxy the total hours flown in Australia by general aviation aircraft and regional RPT aircraft during the study period. "It was assumed that any activity trends appearing in [these] data would be indicative of activity trends within MBZs," the report said, adding that the assumption needs to be taken into account when drawing conclusions from rates. Figure 1 shows an upward trend in the rate of airspace-related occurrences within MBZs. Statistical analysis determined that the average yearly increase in the occurrence rate of 0.427 per 100,000 miles flown was significant ($p<0.005$; i.e., the probability that the increase was attributable to chance was less than five in 1,000).

"Although occurrence rates are one measure of safety within these [MBZ] areas, a more direct measure of risk to the fare-paying passenger may be the occurrence of airmisses," said the report. The numbers of airmisses reported annually increased during the study period (Table 2, page 102). RPT aircraft were involved in 104 of the total 176 airmisses (59 percent). Charter aircraft were involved in 24 airmisses (14 percent).

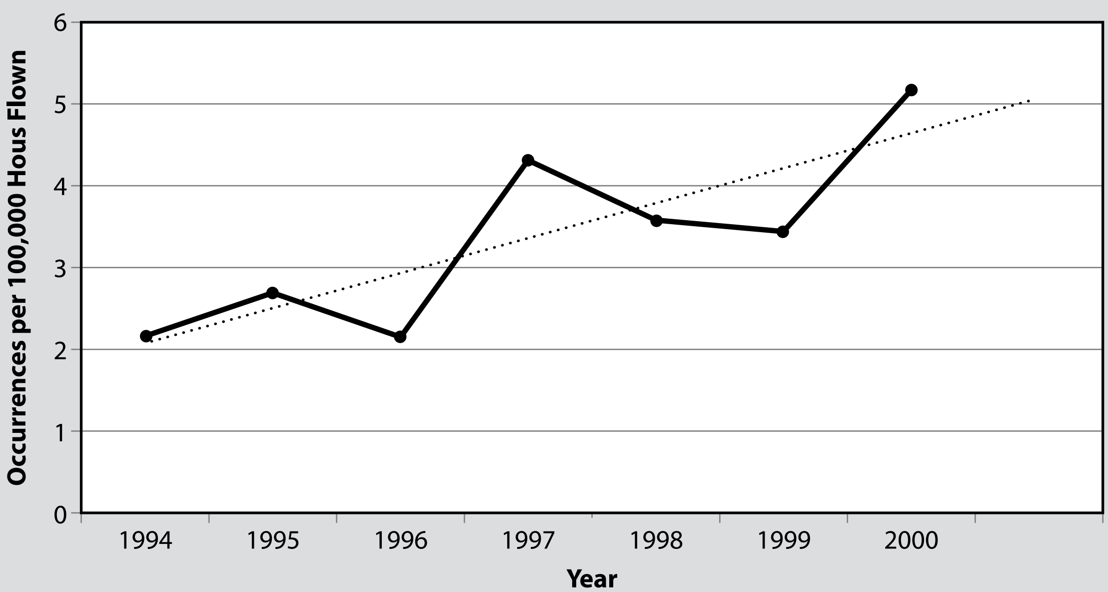
"Although the total number of reported airmisses in MBZs is increasing, the percentage of occurrences which result in airmisses has remained relatively stable, with the exception of a spike in 1996," said the report. Analysis of MBZ airmiss rates per 100,000 hours flown determined that the rates had not changed significantly since 1994 for charter flights and RPT flights (both $p>0.05$; i.e., the probability that the increase was attributable to chance was greater than five in 100).

Factors contributing to airspace-related occurrences in MBZs included the following:

- 89.4 percent involved nonperformance of airspace procedures. Of these occurrences, 77.5 percent involved incorrect radio procedures or no radio procedures, 17.4 percent involved other airspace procedures (defined as "nonperformance occurrences where poor airmanship was evident") and 5.3 percent involved other factors[4];
- 3.8 percent involved lack of operational awareness (defined as "a lack of situational or operational awareness on behalf of the pilot[s]"); and,
- 7.2 percent involved some other contributing factor.[4]

Figure 1

Australian MBZ Airspace-related Occurrence Rates by General Aviation and Regional Airline Hours Flown (with trend line)



MBZ = Mandatory broadcast zone

Source: Australian Transport Safety Bureau

Table 2
Airmisses in Australian MBZs, by Operation Type and Year

	1994	1995	1996	1997	1998	1999	2000	2001	Total
Total Airmisses	10	19	24	27	18	23	26	29	**176**
RPT Airmisses	5	12	10	19	11	13	17	17	**104**
Charter Airmisses	4	7	2	2	1	4	1	3	**24**

MBZ = Mandatory broadcast zone RPT = Regular public transport

Source: Australian Transport Safety Bureau

"From these figures, it can be seen that 'nonperformance — incorrect or no radio procedures' is the factor most commonly contributing to airspace-related occurrences," said the report. "Radio factors contributed to 69.3 percent of all airspace-related occurrences in MBZs."

The analysis could not determine the exact varieties of the nonperformance of radio procedures. But the report said that they probably included not making broadcasts or responses, using an incorrect frequency, having an unserviceable radio or transmitting at the same time as another airspace user.

"Some steps have already been taken in an attempt to increase the safety of aircraft operating within some MBZs," said the report. "However, airspace-related occurrences within MBZs, particularly those relating to radio usage, continue to be of safety concern." ■

[This article, except where specifically noted, is based on *Airspace-related Occurrences Involving Regular Public Transport and Charter Aircraft Within Mandatory Broadcast Zones* by the Australian Transport Safety Bureau, December 2003, and available on the Internet at <www.atsb.gov.au/aviation/research/mbz.cfm>.]

Notes

1. The Australian Transport Safety Bureau (ATSB) defines *occurrence* as "a collective noun for anything unintentional that decreases the safety of a flight operation. In practical terms, this covers the mildest of incidents to the most serious of accidents." Watson, Michael, Australian Transport Safety Bureau. E-mail communication to Darby, Rick. Alexandria, Virginia, U.S., May 20, 2004. Flight Safety Foundation, Alexandria, Virginia, U.S.

   All the airspace-related occurrences in the study were classified as being either Category 4 occurrences or Category 5 occurrences.

   Category 4 occurrences, the report said, "are typically those where the facts do not indicate a serious safety deficiency but investigation is required to substantiate the initial reported facts. The circumstances are sufficiently complex to require detailed information from the pilot, operator and/or other parties. This category may also include a selection of occurrences identified as involving characteristics which, from trend or safety analysis, require investigation." Category 5 occurrences, the report said, "are those primarily of statistical interest and are generally not investigated."

   Several more-serious airspace-related occurrences within the study period might have been linked to MBZ procedures, but because they did not take place within MBZ airspace, they were excluded from the analysis, the report said.

2. ATSB defines an *airmiss* as separation between aircraft of less than 600 meters (1,969 feet) horizontally and 500 feet (152 meters) vertically. The term also includes incidents in which a traffic-alert and collision avoidance system (TCAS) resolution advisory (RA) results in evasive action.

3. The report said, "The term [MBZ] was first officially used in December 1995. Prior to this, the terminology used was [MTAF] areas. The name change resulted from a desire to highlight and reinforce the mandatory requirements to make certain broadcasts. [Although] the majority of MTAF areas became MBZs, some were changed to other airspace procedures … and some new MBZs were developed. These changes were based on airspace use and requirements at the time. Overall, no significant change in the number of MBZs/MTAF areas has occurred. There were no major procedural alterations associated with the name change from MTAFs to MBZs."

4. The numbers did not total exactly 100 percent because of rounding, ATSB said. Watson, Michael, Australian Transport Safety Bureau. E-mail communication to Darby, Rick. Alexandria, Virginia, U.S., May 20, 2004. Flight Safety Foundation, Alexandria, Virginia, U.S.

Fatigue Management on Flight Deck Said to Depend on 'Scientifically Validated' Techniques

Effective countermeasures exist for on-the-job fatigue, but their full application requires a multidisciplinary and industrywide consensus on the nature of the problem and its solutions. Such a consensus is emerging, but progress is slow, says *Fatigue in Aviation*.

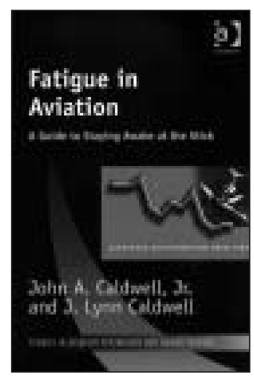
— FSF LIBRARY STAFF

Books

Fatigue in Aviation: A Guide to Staying Awake at the Stick. Caldwell, John A. Jr.; Caldwell, J. Lynn. Aldershot, U.K.: Ashgate Publishing, 2003. 168 pp. Figures, tables, references, index.

The authors ask pilots, "How many times have you struggled through those seemingly endless days when the forces of nature, maintenance delays and miserable schedules left you to wonder how in the world you would ever make it through the flight, much less through the drive home or to the hotel … ? How often have those scratchy eyes, those 'out of focus' instruments, the head-bobs and those really annoying heavy eyelids … made it clear that the alertness of only a few hours ago was definitely a thing of the past?"

Fatigue is defined as "the state of tiredness that is associated with long hours of work, prolonged periods without sleep, or the requirement to work at times that are 'out of synch' with the body's biological or circadian rhythms." The global economy, societal factors and technological advances have made the issue of flight crew fatigue more important now than ever before in the civilian aviation community, the authors say.



In discussing the nature of fatigue as it affects aviation, the authors say that several "myths" have been identified by sleep and fatigue specialist David Dinges, Ph.D. For example: "It has been suggested that a high degree of training, combined with past experience with sleep deprivation and shift work, is the key to avoiding performance problems associated with fatigue from overwork and rotating duty schedules. However, it is clear that people cannot be trained to overcome the effects of on-the-job sleepiness, despite familiarity with the problem and despite the fact that they may ultimately accept difficult working schedules as being 'just part of the job.'

"It has been shown that sleep-deprived people accumulate a substantial sleep debt over time (cumulative sleep loss) which degrades their performance and increases risk by concurrently reducing their ability to accurately judge their own level of impairment."

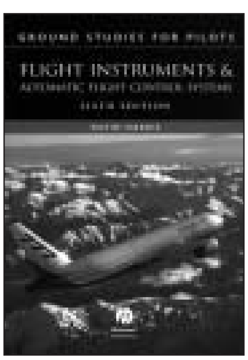
Countermeasures against fatigue are addressed in detail. Such methods include sleep-optimization habits, strategies for maximizing adjustment to schedules that conflict with circadian rhythms (the biological and psychological processes that naturally vary during a 24-hour day) and "strategic napping." The authors conclude with a discussion of establishing alertness-management programs or fatigue-management programs within an organization.

The authors say that there are "substantial societal and political barriers to effective fatigue management." The authors say, "Numerous studies, many of which were conducted by U.S. government researchers, have clearly established the efficacy of napping for sustaining and restoring the performance of fatigued personnel in various environments, including the cockpits of passenger jets; however, disagreements about the implementation of such a strategy in U.S. air operations has resulted in the lack of Federal Aviation Administration approval, despite the approvals of [non-U.S.] regulatory bodies."

Before fatigue in aviation can be counteracted in a fundamental way, the authors say, "there is a need for the scientific, medical and industrial communities to reach a consensus about the problem of fatigue and what can be done to solve it. Apparently such a concordance is in fact developing, but progress has been slow." The needed consensus is that "human fatigue is a problem in terms of safety, health, efficiency and productivity; that fatigue stems from physiological factors that cannot be negated by will power, financial incentives or other motivators; and that once fatigue is finally recognized as a problem, it cannot be effectively managed except through the use of scientifically validated techniques."

[The authors have contributed to articles in Flight Safety Foundation (FSF) publications.]

Fatal Traps for Helicopter Pilots. Whyte, Greg. Birkenhead, Auckland, New Zealand: Reed Publishing, 2003. 396 pp. Figures, index, bibliography.



"We call them 'accidents,' but very few are," says the author. "An accident is 'a chance event; unforeseeable.' Most helicopter [accidents] are extremely predictable. Someone — not always the pilot; sometimes the passenger, engineer or simply a bystander — took a chance, forgot something, ignored a principle or otherwise initiated the [accident]."

The book begins with an overview of the principles of helicopter flight and explains, chapter by chapter, many of the hazards experienced by helicopters and their crews — dynamic rollover, overpitching, main-rotor strikes, midair collisions, mast bumping, engine failures, mechanical failures, ditching, weather-related concerns and many others. For practical applications, the book discusses actual accidents and incidents and offers explanations and diagrams of causes, technical details, survivor accounts and tips on avoiding the same or similar "traps" that led to the accidents and incidents.

Civilian and military pilots, aircraft maintenance personnel, aviation enthusiasts, aviation instructors and accident investigators are among those for whom this book is intended as a useful resource.

The book includes an article on crew resource management for the single-pilot helicopter by Joel S. Harris, originally published in the Flight Safety Foundation publication *Helicopter Safety* (September–October 1995).

Flight Instruments & Automatic Flight Control Systems. Sixth edition. Harris, David. Oxford, U.K.: Blackwell Science, 2004. 384 pp. Figures, tables, diagrams, glossary, index.

This textbook is written for pilots preparing for Joint Aviation Authorities (JAA) airline transport pilot license (ATPL) ground examinations. The book also may be helpful to pilots transitioning from general aviation to commercial flying.

Joint Aviation Requirements (JARs) learning objectives are discussed, as cited in paper no. 022 for flight crew licensing. (Learning objectives are not outlined in the textbook. They are available, however, at the JAA Internet site.) The book is grouped by subject to coincide with the JARs flight crew licensing theoretical knowledge syllabus. The author says, "The text and diagrams in this volume have been deliberately designed to be understandable without [previous] knowledge of the subjects." Model exam questions follow each chapter.

Chapters review air data instruments; gyroscopic instruments and compasses; inertial navigation systems; electronic instrumentation; automatic flight control; in-flight protection systems; and powerplant-monitoring and system-monitoring instruments. Topics discussed reflect recent changes and improvements in automatic flight systems and electronic instrument systems.

This book is part of the *Ground Studies for Pilots* series written to accompany the JARs ground training syllabus guidelines.

Into the Blue: A Father's Flight and a Daughter's Return. Edsall, Susan. New York, New York, U.S.: St. Martin's Press, 2004. 272 pp. Photographs.

Susan Edsall's father was a pilot who collected antique airplanes such as a Vultee BT-13, a World War II trainer, and who lived to fly. Then a stroke left him unable to read, write or speak — much less fly an airplane. Susan, herself a pilot, knew that even if he recovered his faculties, her father would not "be himself" again if he could no longer pilot an airplane. Despite a discouraging prognosis from the doctors, Susan and her sister, Sharon, took charge of their father's rehabilitation in the hope that they could help him beat the odds against recovery.

Months of progress and setbacks, during which their father had to relearn everything he had known about piloting, ensued. Eventually, he received a letter from the U.S. Federal Aviation Administration following a review of his medical records, authorizing a special issuance of his third-class medical certificate. Today, Susan and her father regularly fly airplanes together, the book says.

Reports

Foreign Airline Permits. U.K. Department for Transport. 2 pp. Jan. 8, 2004. Available on the Internet at <www.dft.gov.uk/stellent/groupts/dft_aviation/documents/page/dft_aviation_026674.hcsp>.

Any airline from outside the European Union or European Economic Area must obtain a permit from the U.K. Secretary of State to conduct passenger or freight operations to or from the United Kingdom. "It is a condition of the permit that the airline should be operated in accordance with international safety standards established by the International Civil Aviation Organization [ICAO]," says the U.K. Department for Transport.

Since Jan. 1, 2000, permits have been rejected for a number of airlines, or would have been rejected if an application had been received, because of the airlines' failures to meet ICAO standards, failures to equip their aircraft with a ground-proximity warning system (GWPS) and an airborne collision-avoidance system (ACAS), or other reasons. This report lists the airlines, the dates of permit restriction and the reasons for restriction. Reasons include "inadequate safety regulation," "adverse ramp inspection findings" and "concerns over security and immigration controls."

The Future of Air Transport. U.K. Department for Transport (DfT). Dec. 16, 2003. 20 pp. Table. Available on the Internet at <www.dft.gov.uk/aviation/whitepaper> or from DfT.*

The Government's Response to the Transport Committee's Report on Aviation. Presented to Parliament by the Secretary of State for Transport. December 2003. 17 pp. Available on the Internet at <www.dft.gov.uk/aviation/whitepaper> or from The Stationery Office.**

Among the most critical issues for the aviation industry is maintaining airport capacity to keep pace with the expected growth in air traffic. *The Future of Air Transport* offers a strategic framework for the development of airport capacity in the United Kingdom during the next 30 years. DfT forecasts that by 2030, the number of passengers will increase from about 200 million annually at present to 500 million annually.

"Air travel in the U.K. has trebled in the past 20 years, and air freight has more than doubled in the last decade," says the report. "In that time, no new runways have been provided in the South East [the London metropolitan area] (other than the specialist short runway at London City Airport), and only one elsewhere (at Manchester, which opened in February 2001). The result is that, in the South East, demand for takeoff and landing slots already exceeds capacity at Heathrow [Airport, London], where the runways are full for virtually most of the day. The same is true at Gatwick [Airport, London] for substantial periods, and Stansted [Airport, London] is rapidly filling up."

Among the report's recommendations are the following:

- Two new runways should be provided in the South East by 2030;
- The first new runway should be a second runway at Stansted;
- Within stringent environmental limits, a new runway should be built at Heathrow as soon as possible after the new runway at Stansted; and,
- Land should be reserved for a new runway at Gatwick to be built after 2019 as a fallback option in case the conditions for building a new, third runway at Heathrow cannot be met.

The study does not support proposals for two or three additional runways at Stansted, for a new, close parallel runway at Gatwick or for two new runways at Gatwick.

The Future of Air Transport addresses many issues raised in the Transport Committee's Report on Aviation. The *Government's Response* answers the committee's recommendations briefly, with cross-references to material in *The Future of Air Transport* where appropriate.

Regulatory Materials

Whistleblower Protection Program (Air Carrier). U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 120-81. March 25, 2004. 10 pp. Available on the Internet at <www.cami.jccbi.gov> or from FAA.***

This AC is about a joint program of FAA and the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) that protects workers who report violations or alleged violations related to air carrier safety. The employee protection program meets the requirements of U.S. law, which protects against worker discrimination.

An employer cannot discriminate against a worker who "blows the whistle" and provides information, causes information to be provided or is about to provide information to an employer or the U.S. government about an alleged violation or an actual violation of any regulation, order or standard of FAA or any other provision of U.S. law with regard to air carrier safety.

Examples of reportable air safety violations include the following:

- Falsification of records;
- Noncompliance with flight and rest requirements;
- Improper maintenance practices;
- Security breaches;
- Inadequate compliance with training requirements;
- Use of suspected unapproved aircraft parts;
- Improper manufacturing procedures;
- Failure to meet crewmember medical qualifications;
- Improper production of aircraft parts; and,
- Instructions to ignore documenting aircraft maintenance discrepancies.

Discrimination against workers can take many forms. Examples are threats, warnings, harassment, intimidation, reprimands, salary reduction, demotion, reassignment, altered work schedule and discharge from employment.

To qualify for protection under the Whistleblower Protection Program, two criteria must be met: The reported information must be related to a violation or alleged violation of air carrier safety, and the employer must have discriminated against the worker for reporting such information.

The AC provides guidance for employees of U.S. air carriers, employees of companies performing under contract to U.S. air carriers and subcontractor employees of U.S. air carriers in reporting concerns related to air carrier safety (not personal safety). The AC contains instructions for filing safety complaints with FAA or OSHA and filing discrimination complaints with OSHA. Investigation procedures are explained, and relevant FAA and OSHA telephone numbers are listed.

Additional information about the Whistleblower Protection Program is available on the Internet at <http://www.faa.gov/avr/afs/whistleblower>.

Crew Resource Management (CRM) Training. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 120-51E. Jan. 22, 2004. 27 pp. Available on the Internet at <www.cami.jccbi.gov> or from the U.S. Department of Transportation.****

Crew resource management evolved from cockpit resource management, which applied solely to the flight deck environment, to include flight attendants, maintenance personnel and others. CRM training applies team-management concepts to effectively use all available resources: human, hardware and information. Human resources may include aircraft dispatchers, air traffic controllers and other employee groups that routinely work with the flight crew and are involved in decisions affecting the safety of flight.

The three components of CRM training — initial indoctrination or awareness, recurrent practice and feedback, and continual reinforcement — employ elements of team building, information transfer, problem solving, decision making, task allocation, communication, situational awareness and automated systems to address challenges posed by human–machine interaction and person–person interaction.

This AC provides guidelines for developing, implementing, reinforcing and assessing CRM training. The guidelines, originally intended for organizations operating under U.S. Federal Aviation Regulations (FARs) Part 121, have been expanded to include fractional ownership programs operating under Part 91 and Part 135 operators conducting training in accordance with Part 121 requirements. Other operators may find these guidelines useful in addressing human-performance issues.

Principal changes in this revision are the following:

- Operators of fractional ownership programs under Part 91, subpart K, are now required to provide CRM training to pilots and flight attendants;
- The most threatening safety and security situations, such as evacuation or hijacking, are now included in subjects that captains' briefings should address;
- A new subparagraph, "Crew Monitoring and Cross-checking," emphasizes the critical role of monitoring by the pilot not flying; and,
- Conditions requiring additional vigilance, such as passenger interference or attempted hijacking, are now included as appropriate CRM training topics.■

[This AC cancels AC 120-51D, *Crew Resource Management Training*, dated Feb. 8, 2001.]

Sources

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P.O. Box 236
Wetherby LS23 7NB
United Kingdom

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P.O. Box 29
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AFS-200W, Room 831
800 Independence Ave. SW
Washington, DC 20591 U.S.

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Subsequent Distribution Office, SVC-121.23
Ardmore East Business Center
3341 Q 75th Ave.
Landover, MD 20785 U.S.

LIBRARY

First Officer Retracts Flaps Instead of Landing Gear After Takeoff

The report on the incident said that the captain had called for retraction of the landing gear during the Boeing 717's departure from an airport in Australia. Instead, the first officer moved the flaps/slats lever.

— FSF EDITORIAL STAFF

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

First Officer's Move Described As 'Action Slip'

Boeing 717. No damage. No injuries.

Immediately after takeoff on a domestic flight in Australia, the captain, who was the pilot flying, called for the landing gear to be retracted. Soon afterward, he observed an amber warning on the airspeed scale on his primary flight display (PFD) and reduced the airplane's pitch attitude. At the same time, he observed that the flaps/slats lever was in the "SLATS RETRACT" position.

The incident report said, "The [captain] immediately called for the flaps to be repositioned, but the copilot selected the landing gear up. The [captain] again called for the flaps to be repositioned, and the copilot then returned the flap selector to the takeoff position. The [captain] reduced the pitch attitude further. The airspeed then quickly increased to 15 knots above the reference speed … as the flaps reached the takeoff position."

After the airplane was re-established in a normal climb attitude, the flaps and slats were retracted, and the remainder of the flight was uneventful.

The report said that the copilot's actions "appear to have been an 'action slip' — a type of procedural error associated with two actions (landing gear [retraction] and flaps/slats retraction) that are sequentially linked. As was the case here, in human behavior, there can sometimes be a spillover that triggers the associated action at an inappropriate time."

After the incident, the operator cooperated with the Australian Transport Safety Bureau in distribution of a survey to company pilots who flew Boeing 717 airplanes; the survey revealed that on three other occasions, flight crewmembers had moved the flap/slats lever through the "FLAPS ZERO" position to the "SLATS RETRACT" position. Each of those events occurred above 3,000 feet, however, and none involved retraction of the landing gear.

Probable Icing Cited in Aircraft Control Problem

BAE Systems BAE 146. No damage. Two serious injuries, two minor injuries.

During an afternoon flight from England to Northern Ireland, the flight crew observed that during climb, the airplane "appeared to hunt in pitch more than usual" when the autopilot was engaged. After the autopilot was disengaged, the airplane pitched up. Heavy elevator control forces were required to counteract the pitch-up. The flight crew applied nose-down trim, and the airplane's nose "pitched down at a marked rate," the accident report said.

"In an attempt to level the aircraft, both pilots then pulled back on the control columns with considerable force. The controls suddenly freed, causing the aircraft to pitch up rapidly, resulting in a large excursion in normal acceleration, which caused serious injuries to two cabin crewmembers."

The crew declared pan-pan, an urgent condition, and told controllers that they planned a continuous shallow descent to the destination airport, with shallow turns. They said later that control forces and aircraft response were normal for the remainder of the flight.

The report said that the accident probably was caused by "icing of the elevator servo tabs, coupled with the crew's response to the situation, for which they had not been trained."

The airplane had been parked overnight on the apron (ramp) at an airport in Northern Ireland and had been treated with deicing/anti-icing fluid at 0200 local time. The flight crew reported at 0555 for four flights. The first three flights proceeded without incident. Before the fourth flight, the airplane was on the ground for 55 minutes in weather conditions that included a mixture of rain, sleet and snow; the airplane was not deiced before takeoff. During preflight checks, the flight crew held the control column fully back for 25 seconds, in compliance with company policy that had been valid until two months before the accident and never superseded, to allow drainage of any accumulated water.

The report said, "Although snow was not settling on the visible parts of the aircraft, it is possible that in the near-freezing conditions, snow or slush could have accumulated in the sheltered areas in the gaps between the elevators and the servo tabs and this would not have been visible to the crew."

Tires Fail After In-flight Brake Check

Airbus A300. Minor damage. No injuries.

Visual meteorological conditions prevailed for the morning landing at an airport in the United States. The captain said that company maintenance personnel had asked her to conduct an "alternate brake in-flight test"; she did so at the top of the airplane's ascent. She wrote on a maintenance form, "Good pressure, left shows 2100, right shows 2500; however, we get a brake fail light and ECAM [electronic caution alert module] amber alert 'AUTO BRK FAULT.'"

A preliminary report said that after the test was completed, the captain "returned the switch to the normal position," and the flight crew conducted an instrument landing system approach. The captain described the touchdown as "normal (and) smooth," but during the rollout, there was a "brake-dragging feeling."

The report said, "The captain asked the first officer (FO) if he had brakes on, and he answered no. The FO stated [that] 'shortly after touchdown, it felt as if the autobrakes came on' but that he had not selected autobrakes."

Controllers in the airport air traffic control tower told the crew that they could see smoke and flames from the main landing gear. The crew evacuated the airplane. All eight main-landing-gear tires failed during the landing roll.

Electrical Short Circuit Causes Fire After Landing

Beech B100 King Air. Minor damage. No injuries.

As the flight crew taxied the airplane from a runway after a morning landing at an airport in Canada, they observed smoke and flames emerge from beneath the electrical panel. They declared an emergency and shut off all electrical equipment, and the flames were extinguished.

A report said that windows in the airplane mistakenly had been left open the previous night. As a result, rainwater had entered a circuit board. When the landing lights were selected before landing, a short circuit resulted.

Power Loss Results in Emergency Landing

Piper PA-31-350 Chieftain. Substantial damage. No injuries.

About five minutes after departure from an airport in Australia, as the pilot of the charter aircraft flew the airplane through 5,000 feet, the right fuel-flow warning light illuminated. The pilot moved the mixture-control lever for the right engine to "FULL RICH" and told air traffic control (ATC) that he was returning to the departure airport.

After the right engine began surging, the pilot changed the fuel selector for the right engine from the inboard fuel tank to the outboard fuel tank, which he knew contained only a small amount of fuel. The engine continued surging, and the pilot reselected the inboard fuel tank. He said that he did not shut down the right engine because it continued to produce power.

About one minute after the onset of the problem with the right engine, the left fuel-flow warning light illuminated and the left engine began surging. The pilot told ATC that he was diverting to a closer airport. After flying the airplane through a break in the clouds, he leveled the airplane and "reported that the engines operated smoothly but at reduced power," the accident report said.

After he reduced power to reduce airspeed below blue-line (best single-engine rate of climb) speed, however, he could not maintain the airplane's altitude and conducted an emergency landing in a field; during the landing, the right wing tip struck the ground.

The report said that the pilot's description of the event was "consistent with fuel starvation, a situation where the fuel [flow] to the engine is interrupted, although there is adequate fuel on board the aircraft."

Tests showed that the left high-pressure fuel pump did not produce the required pressure and fuel flow and that it leaked; nevertheless, the faulty pump would have had little effect on the occurrence, and the damage may have been a result of the accident, the report said.

The report said that investigators were "unable to reconcile the pilot's reported recollection of inboard tank selection and the evidence of the remaining fuel quantities in the inboard tanks."

Control Loss Follows Landing On Snow-covered Runway

Dassault Aviation Fan Jet Falcon. Substantial damage. No injuries.

Night instrument meteorological conditions prevailed for the business flight to an airport in the United States. The copilot, who was the pilot flying, said that the landing was normal and that he had "no problems with runway conditions" until he activated the airplane's thrust reversers and the airplane yawed left, causing a loss of control. A witness said, "I heard the (thrust) reversers go on and then off and then on again. As they came back on for the second time, that's when the plane started making full circles on the runway. This happened two [times], maybe three times before going off the side of the runway."

At the time, the runway was covered with about 0.8 inch (2.0 centimeters) of wet snow.An inspection of the airplane showed that the right engine thrust reverser was in the stowed position, and the left engine thrust reverser was deployed.

In-flight Failure of Spoiler System Causes Airplane to Roll Left

Learjet 45. No damage. No injuries.

Visual meteorological conditions prevailed and an instrument flight rules flight plan had been filed for the business flight in the United States. The airplane was being flown in a descent in preparation for an approach when, at 13,000 feet, the captain extended both spoilers to help reduce the airplane's speed.

The incident report said that the left spoiler deployed, but the right spoiler "barely moved," and as a result, the airplane rolled left. The "SPOILER FAIL CAS" light illuminated. The captain retracted the spoilers, rolled the airplane level and conducted the appropriate emergency checklist.

The flight crew continued to the destination airport, where they conducted a normal landing.

The report said that the probable cause of the incident was "the failure of the airplane's spoiler system when used as speed brakes due to high resistances in the spoilers' actuator coils."

Spark-plug Failure Cited in Partial Power Loss

Intreprinderea De Avioane Bacau (Yakovlev) Yak-52. Minor damage. No injuries.

The pilot was conducting touch-and-go landings at an airport in England. During climbout after the third landing, at 300 feet to 400 feet, the engine began to run roughly and to produce less power. The pilot observed an increase in indicated cylinder-head temperature.

The pilot retarded the throttle and turned the airplane toward the airport, then decided that the airplane was too high and too close for a landing on the reciprocal runway. He continued downwind, planning to land the airplane on the takeoff runway, but when he advanced the throttle, the engine began running roughly again. The pilot decided to land the airplane straight ahead in a field.

The report said, "At the last moment, having by that stage committed himself to landing, with the landing gear down, the pilot saw that the 'threshold' end of the field was bounded by a row of fence posts." The airplane struck three of the posts.

Examination of the engine revealed that the insulator core of a spark plug in the no. 4 cylinder was missing and the spark plug casing had been burned through.

"It was reported that this is not a unique occurrence with Yak-50/52 aircraft and that although there is an attendant risk of fire within the engine compartment, the engine will continue to produce reduced power for a significant period of time," the report said.

Potential Buyer Conducts Landing, Airplane Rolls Off Runway

Cessna 182P. Substantial damage. No injuries.

Visual meteorological conditions prevailed as the owner of the airplane and a potential buyer conducted their second flight in two days from an airport in South Africa. As they neared an airport and prepared for a landing, they were unable to extend the flaps, probably because of an electric motor failure. The airplane owner, who also was a flight instructor, conducted a landing without flaps. During the return flight, the potential buyer — who was also a pilot — flew the airplane. The report said that the owner observed that the potential buyer had inadequate flying skills and below-average basic knowledge of flying. The two discussed the no-flaps-landing procedure before the potential buyer conducted the landing. The airplane floated above the first half of the runway because of excess approach speed and a slight tail wind. After touchdown, the potential buyer applied full brakes. The owner told him to release the brakes, and he complied briefly and then applied the brakes again and did not respond when the owner told him to release the brakes and to turn the airplane right. The owner tried to take control but could not overpower the potential buyer.

The airplane continued beyond the departure end of the runway and over an embankment.

Emergency Landing Follows Extended Fire Fighting Flight

Air Tractor AT-802. No damage. No injuries.

The pilot was flying the airplane toward an airport in Canada after completing a night fire-control flight when the engine stopped because of fuel exhaustion. The pilot conducted an emergency landing in a field.

The incident report said that the pilot "had actioned three separate fire locations, two of which were unplanned before departure." He was delayed in dropping fire retardant at the third location for "operational reasons," the report said. Afterward, he encountered strong head winds as he flew the airplane toward the destination airport.

ROTORCRAFT

Pilot Prepares for Hover Flight, Main-rotor Blades Strike Tree

Eurocopter AS 318 Alouette II. Substantial damage. No injuries.

The helicopter was being flown on an aerial inspection of a farm in South Africa. The pilot flew the helicopter up a valley, maintaining an altitude about 1,000 feet above the altitude of the takeoff point. As the helicopter reached an area of higher elevation, the pilot began reducing airspeed to enter hover flight.

When the helicopter was nearly in a hover about 50 feet above a mountain, the pilot realized that the descent rate was too fast. He conducted an emergency landing in an area that appeared suitable, but during the landing, the main-rotor blades struck a tree, and the pilot landed the helicopter atop a ridge. As the helicopter was shut down, the main-rotor blades again struck the tree.

The pilot said that, because the wind direction was changing constantly, he had difficulty maintaining the helicopter's heading into the wind.

The accident report said that the probable cause was that "the pilot did not anticipate the effect of mountain waves (downdraft, tail wind component) and ended up running out of power (control difficulty) once he had cleared the ridge, with the aircraft descending into terrain."

Misaligned Drive Shaft Blamed For In-flight Vibration

Enstrom F28F Falcon. Minor damage. No injuries.

After takeoff from a private helipad in England, the pilot flew the helicopter to about 1,000 feet and then felt "a kick to the left, followed by an abnormal vibration," the accident report said. The vibration increased as the helicopter's speed accelerated to 100 miles per hour in level flight. The pilot returned to the helipad for a precautionary landing. An examination of the helicopter revealed that the tail-rotor drive shaft was improperly aligned. The drive shaft runs the length of the tail boom and is supported by five roller bearings located within blocks and with rubber bushings between each block and bearing. The report said that the rubber bushing from the no. 4 bearing was damaged and out of position.

"The [bushing] had become swollen from prolonged contact with grease," the report said. "This had resulted in wear of the [bushing] due to contact with the block [while] the [bushing] was rotating."

Pilot Suspects Transmission Problem as Cause of Hard Landing

Hiller UH-12E. Substantial damage. One minor injury.

Visual meteorological conditions prevailed for the approach to an airport in the United States. The pilot was returning to his base after an agricultural spraying flight about 40 nautical miles (74 kilometers) north of the base. As he flew the helicopter through 100 feet at about 60 knots, he heard a bang and transitioned immediately into autorotative flight.

The pilot flared the helicopter before touchdown, but because of insufficient rotor speed, the helicopter landed hard and the main-rotor blades severed the tail boom. The pilot said that as the helicopter struck the ground, he heard the engine spooling up. He said that a transmission malfunction might have led to the hard landing.

Helicopter Strikes Power Line After Cattle-mustering Flight

Robinson R22 Beta. Substantial damage. Two minor injuries.

Visual meteorological conditions prevailed for the cattle-mustering (cattle-herding) flight in Australia. After herding the cattle into a small paddock, the pilot conducted an approach, intending to land the helicopter next to a fence.

The pilot said later that he had observed an electrical power line and had planned the landing for a point where the power line changed direction. The accident report said that the pilot had not seen another power line, and the helicopter struck that line about 30 feet above ground level. The helicopter spun to the ground and landed on a barbed-wire fence. ■

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