

## Flight Operational Quality Assurance (FOQA) Applied to Flight Inspection

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### ABSTRACT

This paper presents the first steps taken by the U.S. Federal Aviation Administration (FAA) Office of Aviation System Standards (AVN) to applying FOQA to its flight inspection program. The issues presented include:

- The definition of Flight Operational Quality Assurance and some essential terminology.
- How FOQA is being used in the Airline Industry
- The concerns of confidentiality from the crews
- The application of FOQA data to increasing the effectiveness of Flight Inspection training
- FOQA data applied to increasing the safety of Flight Inspection operations
- Future considerations

This paper presents an overview of Flight Operational Quality Assurance, how it is being implemented in the airline industry, the benefits being obtained, how the FAA implemented rule making to protect the data taken from flight data recorders to relieve the concerns expressed by crewmembers on punitive action. It will discuss how AVN has worked with its management, its contractor and the Labor Union, chosen the event sets to be measured, how the data will be protected and initially be applied to improving the flight inspection training program, and to improving the safety of flight inspection operations. Lastly, the future direction and expectations of the FOQA program will be discussed.

### THE DEFINITION OF FOQA AND SOME ESSENTIAL TERMINOLOGY

Flight Operational Quality Assurance (FOQA) is a program for the routine collection and analysis of digital flight data generated during line operations to provide more information about, and greater insight into, the total flight operations environment. The information and insights provided by FOQA can also be used to reduce operational costs and significantly enhance training effectiveness, operational procedures, maintenance and engineering procedures, air traffic control procedures, airport surface issues and, in the present case, flight inspection operational procedures. FOQA data is unique because it provides objective data that is not available through any other methods.

**FOQA Events** – The detection of deviations from the normal operating envelope. They are classified at different levels of seriousness ranging from minor deviations from normal operating procedures (“Detects”) to serious deviations from normal operating procedures with possible safety implications (“Alerts”).

**Detect or Alert Event** - An event, as determined by recorded flight data, indicating that an aircraft was in a situation outside the normal flight operations tolerances. Example: an aircraft, on a visual approach not associated with the mission, at 500 feet AGL, flaps not in the landing position, and  $V_{REF} + 60$  knots.

**Normal Event (Routine Operational Measurement)** - An event in routine operations that has not exceeded any defined aircraft limitations, but is of statistical interest and measured and recorded for trend analysis purposes. Example: the rate of rotation on takeoff. See Figure 1 for an example of events of interest.

**Ground Data Replay & Analysis System - (GDRAS)** – software that transforms flight-recorded data retrieved from a variety of recorded data formats and airborne systems into a usable format for processing and analysis; processes the data; determines what events were detected in-flight; and generates reports and visualizations to help personnel interpret events. A GDRAS can:

- Read the data layout and formats prescribed by aircraft data acquisition system specifications (as provided by the manufacturer).
- Transform raw digital flight records into a form that can be processed.

- Apply algorithms to convert the transformed data into engineering units.
- Analyze flight information.
- Generate information on any detected events that represent deviations from normal operating envelopes or exceptional conditions. These operating envelopes consider aircraft operating limitations, and they are based on information from aircraft flight manuals and accepted practices for safe operation.

**Flight Visualization System** - a software program that allows visualization of aircraft data in three dimensions with airport runways, surrounding terrain, full and active instrumentation and nav aids.

**FOQA Monitoring Team (FMT)** - A committee of Management and Union representatives that examines information derived from FOQA data, proposes corrective actions, tracks the implementation of these corrective actions, and validates the efficacy of the actions through continuous data monitoring.

**Gatekeeper(s)** - Member(s) of the FMT appointed by the Union. Gatekeepers are the only persons able to access identifying information that would associate a particular flight crew with an event. This gives the Gatekeeper the ability to contact the flight crew for the purpose of gaining more information and insight about the event and will improve the FMT analysis of the event. It is expected that calls from the Gatekeeper to flight crewmembers will be infrequent occurrences. See Figure 2 for a graphical depiction of how the data will flow through the program.

## HOW FOQA IS BEING USED IN THE U.S. AIRLINE INDUSTRY

In 1991, the FAA contracted with the Flight Safety Foundation (FSF) to examine the technology, benefits, and other issues that arose from FOQA programs used by airlines around the world. In its 1992 report on FOQA, FSF indicated that "the appropriate use of FOQA data by airlines, pilot associations, and aircraft and equipment manufacturers would result in a significant improvement of flight safety by identifying operational irregularities that can foreshadow accidents and incidents." As a result of this study, the FSF recommended that the FAA initiate a program to examine the benefits that FOQA programs might provide to U.S. airline operators.

A demonstration study is being conducted in response to a joint industry-government recommendation concerning FOQA, which resulted from the DOT Aviation Safety Conference conducted in January 1995. The conference recommended that the FAA take action to encourage and facilitate the voluntary implementation of FOQA programs by US airlines, and in particular, that the FAA sponsor a FOQA demonstration study to provide a sound basis for developing guidelines in this area. The goal of the

demonstration study, begun in July, 1995, and called "DemoProj" is to facilitate the start-up of the FOQA initiative, to document safety enhancements and cost benefits of FOQA programs; assess technology alternatives; develop guidelines for FOQA programs in the U.S.; and address organization strategies for information use, protection, and management. As of April 2004, there were 14 major U.S. Airlines with FAA-approved FOQA programs. These airlines have started FOQA programs because they have been able to use flight data to make significant improvements in the safety of their operations, as well as achieve significant cost savings their maintenance programs.

## THE CONCERNS OF CONFIDENTIALITY FROM THE CREWS

First of all, it's not a "big brother" program. Surveillance of individual pilot performance is not a program objective. The real value of FOQA comes from examining the aggregate trend data generated by the program, rather than by anything from a single flight, and that's where the focus will be.

U.S. pilots have been operating with FOQA programs for a number of years now without any violation of trust by either their management or the FAA. They have worked as partners with their managements to improve safety and efficiency. AVN's position is that its flight operations should be at the forefront of the nation's aviation safety efforts, including FOQA.

The FAA recently issued Federal Aviation Regulation (FAR) Part 13401, Flight Operational Quality Assurance Program, which prohibits the use of data obtained from an FAA-approved FOQA program from being used in FAA enforcement actions; FAR Part 193, Protection of Voluntarily Submitted Information, which protects voluntarily-submitted safety data from disclosure under the Freedom of Information Act (FOIA); and FAA Order 8000.81, Designation Of Flight Operational Quality Assurance (FOQA) Information As Protected From Public Disclosure Under 14 CFR Part 193, which brings FOQA data under the provisions of FAR Part 193.

For these protections to be available, it is necessary to develop a FOQA Implementation and Operations Plan, submit that plan to the FAA Flight Standards Service and have the program approved. AVN is in this process now, and should have its program approved by 30 SEP 04.

A negotiated Memorandum of Understanding between AVN Management and the Union prohibits using any FOQA data against a pilot in a grievance, to corroborate information from another source, to discipline, or to require a pilot's submission to a non-recurrent proficiency check or line check. The program can be suspended in the event of non-compliance with the Memorandum of Understanding.

The first step in the analysis process by the FOQA GDRAS is to automatically "de-identify" the flight by concealing all

information that could identify the crew (e.g., flight number, day of the month, and location). Only the Gatekeeper has password access to these data; the Gatekeeper will use it only if it is necessary to contact the crew to obtain more information to clarify an event.

The FOQA data only show what the aircraft was doing at any given time. They will probably not indicate the reasoning behind why the aircraft was flying the way it was. Only the pilot knows the answer to that question. In many cases, a pilot may be just using good judgment, such as increasing takeoff speeds when windshear is encountered on the runway.

### **THE APPLICATION OF FOQA DATA TO INCREASING THE EFFECTIVENESS OF FLIGHT INSPECTION TRAINING**

AVN is in a continuous training mode for its flight inspection pilots and airborne technicians, either initial training or recurrent training. Currently, the flight inspection maneuvers are described and depicted in training materials and policy directives. Pilots and technicians are trained both together and separately at Oklahoma City in a fixed base simulator. The simulator has the flight inspection system avionics mounted in racks and connected similar to what is found in the flight inspection aircraft. Real time training in the aircraft is accomplished on actual flight inspection missions.

A change to the training technique, which will employ FOQA data, is to supplement the simulator training with flight training missions that are not actual flight inspection missions for new pilots working toward Second-in-Command certification. Dedicated maneuvers for checking each type of navaid will be flown in accordance with a training syllabus. Once back on the ground, the data from both the aircraft and the flight inspection system will be downloaded, processed through the GDRAS and displayed on the Flight Visualization System. There, it can be replayed as many times as needed to see exactly how the training mission was flown. Not only can the aircraft instrumentation and path in space can be visualized, but also the navaid signal in space can be displayed. The data collected on these training flights will eventually be consolidated in the training and standardization branch for use in training both current and future flight inspectors.

### **FOQA DATA APPLIED TO INCREASING THE SAFETY OF FLIGHT INSPECTION OPERATIONS**

Very sophisticated analysis software will take the data and translate it into something that can be read by regular human beings. The software will be configured so that it reflects the needs and realities of AVN's flight inspection mission. Much of the analysis process is automated by the software, as it compares the data against a pre-defined set of events and finds instances where performance falls outside of what would be considered normal for the phase of flight.

The data can tell us that something happened out of the ordinary, but it won't tell us why it happened. We will use both experienced line and instructor pilots in the analysis, but there are some things that we won't be able to figure out from the data alone. It will be necessary for the Gatekeeper to contact the crewmembers on that flight, to get the whole story.

The information provided by the crew will be used to determine whether the event was valid. Instructions from ATC, adverse weather, and the very nature of the flight inspection mission, such as below path clearance runs, and Approach Path Monitor checks can set up some unusual situations. For example, in many of the runs just described, the GPWS will be alerting, but must be ignored to continue the run. The GPWS alert will trigger an event. With crew-provided information, it can be determined whether an occurrence really fell outside of normal operations. If the event is valid, the FMT will work to determine what factors lead up to the aircraft getting into the situation – and how to prevent it in the future.

The information gleaned from an individual flight will not be the focus of the program. FOQA shows its real value when we aggregate the information to determine trends. These trends can reveal problems that are systemic and our focus will be on correcting those problems. We will take corrective actions, which may include everything from changes in training to working with ATC to simply making pilots aware that the problem exists. Then, we will continue to monitor the data to track the effectiveness of the corrective action. With the flight visualization program capability, we envision the possibility of making audio/visual tracks of flight inspection runs during normal operations, and making those available to ATC for increasing their understanding of the flight inspection mission, in the hope of improving our coordination with and handling of flight inspection mission aircraft by the controllers. This program is about closing the loop in the safety process by looking at what the data tells us, acting upon it, and then letting the data tell us whether those actions have led to desired results.

Event #	Event Name	Event Description	Event Value	Detect Duration	Alert Value	Alert Duration	Reference
42	Landing Gear Operation	An event that detects when the indicated airspeed of the aircraft exceeds the maximum allowable airspeed for operation of the landing gear in transit.					
43	Operation Left of Localizer Centerline	An event to detect deviation left of localizer centerline.					
44	Operation Right of Localizer Centerline	An event to detect deviation right of localizer centerline.					
45	Operation Above Glideslope	An event to detect deviation above Glideslope.					
46	Operation Below Glideslope	An event to detect deviation below Glideslope.					
47	Descent Below MDA	An event to detect descent below MDA (followed by a climb back to MDA) on non-precision approaches.					

Figure 1: Example of Events that are of Interest

## FUTURE CONSIDERATIONS

The AVN FOQA program is planned as a limited-scale program that will evolve into a larger, more comprehensive program. It will initially be implemented on selected Learjet 60 aircraft and will be expanded to the entire Learjet and Challenger fleets as resources permit. It is not anticipated that the Beechcraft fleet will be brought into the FOQA program. It is planned that the follow-on aircraft to the Beech will be configured for FOQA when they arrive at AVN, and that our Aircraft Maintenance program will be brought into the FOQA program as well. This phased approach will ensure that all concerns are addressed and that the flight inspection pilots, technicians, mechanics, management and the union are comfortable with the program as it grows to maturity.

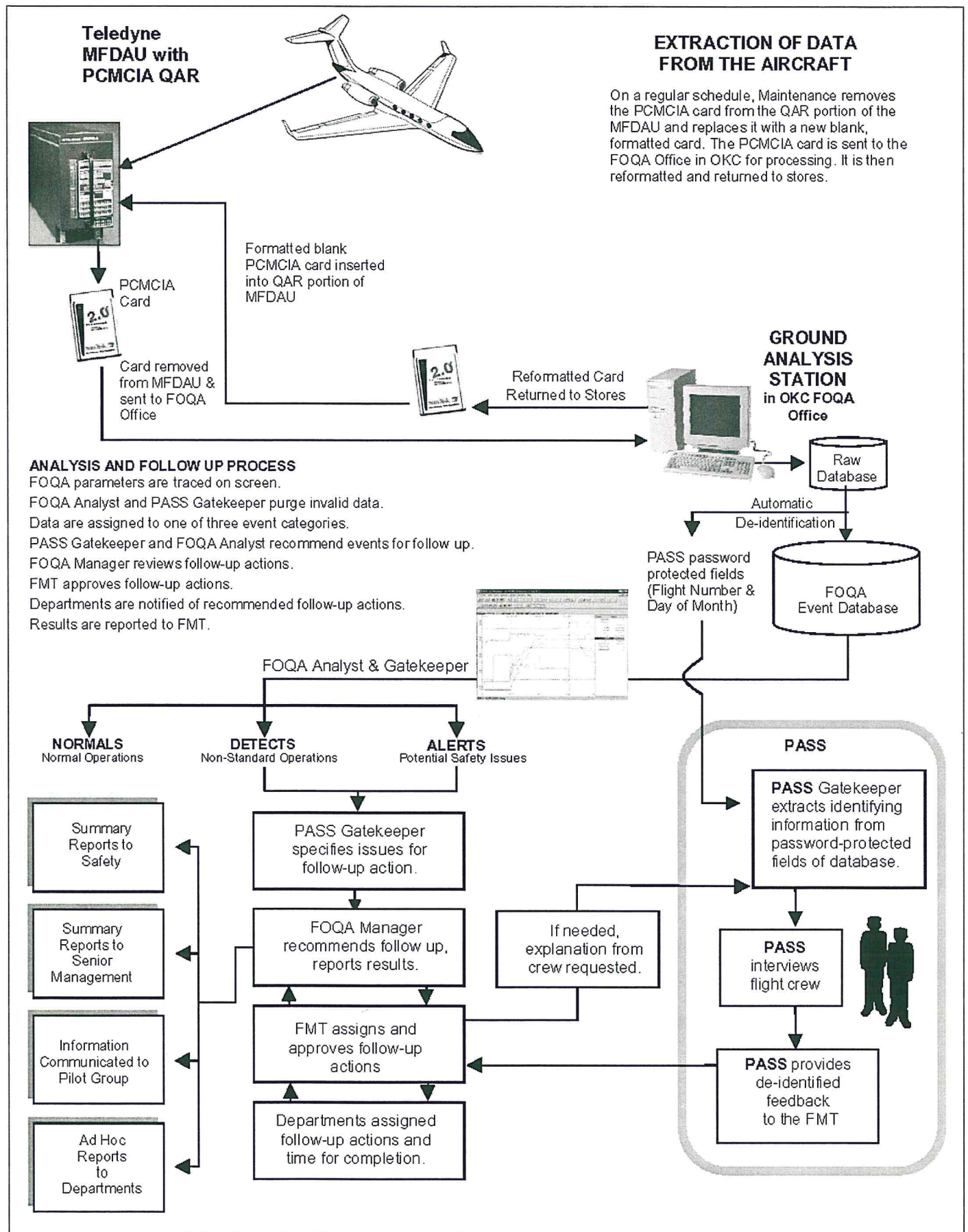


Figure 2: How the Data will flow through the FOQA Program

