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Data Quality Improvements for FAA

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Richard Perry, P.E., Colonel, USAF (ret), MO3645
Karen Marlman
David Olson, Captain, USN (ret)
Dr. Paul Werner
Sandia National Laboratories
U.S. Department of Energy, Albuquerque, New Mexico

In conjunction with

Flight Standards Service,
Federal Aviation Administration, Washington DC

and

Airport and Aircraft Safety Research and Development Division,
Federal Aviation Administration, Washington DC

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Introduction

Effective communication among air safety professionals is only as good as the information being communicated. Data sharing cannot be effective unless the data are relevant to aviation safety problems, and decisions based on faulty data are likely to be invalid. The validity of aviation safety data depends on satisfying two primary characteristics. Data must accurately represent or conform to the real world (conformance), and it must be relevant or useful to addressing the problems at hand (utility). The Federal Aviation Administration, in efforts to implement the Safety Performance Analysis System (SPAS), identified significant problems in the quality of the data which SPAS and FAA air safety professionals would use in defining the state of aviation safety in the United States. These findings were reinforced by Department of Transportation Inspector General and General Accounting Office investigations into FAA surveillance of air transport operations.

Many recent efforts to improve data quality have been centered on technological solutions to the problems. These technical approaches are closely related to earlier "quality control" methodologies. They concentrate on reducing errors in the data (conformance), but they cannot adequately address the relationship of data to need (utility). Sandia National Laboratories (Sandia), working with the FAA's Airport and Aircraft Safety Research and Development Division and the Flight Standards Service, has been involved in four programs to assist FAA in addressing their data quality problems. The Sandia approach has been data-driven rather than technology-driven. In other words, the focus has been on first establishing the data requirements by analyzing the FAA's surveillance and decision-making processes. This process analysis looked at both the data requirements and the methods used to gather the data in order to address both the conformance and utility problems inherent in existing FAA data systems.

This paper discusses Sandia's data quality programs and their potential improvements to the safety analysis processes and surveillance programs of the FAA.

Background

Sandia National Laboratories is part of the national laboratory system established by the U.S. Department of Energy. Its primary mission involves the design, fabrication, operation, maintenance, storage, transportation, and decommissioning of nuclear weapons. The broad expertise developed by Sandia National Laboratories (Sandia) in ensuring the reliability, security, and safety of nuclear weapons is relevant to a broad range of high consequence operations including commercial aviation.

Sandia's work for the FAA began in 1991 when the FAA's Airworthiness Assurance NDI (non-destructive inspection) Validation Center was established at Sandia in Albuquerque, New Mexico. The interagency agreement was later modified to allow the FAA to use Sandia's full capabilities.

Sandia began working with the FAA on data-related issues with a program to independently verify and validate the Safety Performance Analysis System (SPAS). SPAS was being developed as an automated decision support system to allow the Flight Standards Service (AFS) to use existing government data primarily from the Flight Standards Information System (FSIS)¹ to assist air safety inspectors in assessing the safety of air carriers. Sandia and others recognized shortcomings in the underlying data in FSIS which had the potential to undermine the effectiveness of SPAS. Reports by the General Accounting Office (GAO)¹ specifically identified the Program Tracking and Reporting Subsystem (PTRS), which records the results of surveillance inspections, as suffering from poor data quality.

To assist FAA and AFS in addressing data quality concerns, Sandia expanded its work with FAA. These additional projects included modeling data requirements and applying statistical and human factors analysis techniques to improve the conformance and utility of FSIS data. Initial analysis of existing databases and the current processes used to collect data have identified significant improvement potential. These projects will continue and will assist in reengineering databases and data collection processes to improve data quality and meet changing requirements of AFS.

Early work in these projects identified a significant need for better defining the environment in which FAA operates in order to establish the data requirements necessary for that environment and to assess the effect of anticipated changes in FAA operations in the context of that environment. The Framework 2000 project was initiated to fill that need through an externally-focused analysis of the participants in the aviation environment, their interactions, and the constraints (regulatory and otherwise) which influence them.

Two studies, *Challenge 2000*,² and the *FAA 90-Day Safety Study*,³ were released in the summer of 1996. They identified areas of significant change necessary within FAA to address existing deficiencies in FAA operations and to allow the FAA to take advantages of technical advances and to adapt to a changing business environment within the world aviation community.

The surveillance process is the principal source of information used by AFS to evaluate air carrier safety. It is also the main source of data recorded by the PTRS. Because of the critical contribution of PTRS to SPAS and the key role of surveillance in aviation safety assessment, the surveillance process, itself, must be included in any effort to improve data quality or enhance aviation safety. To address the deficiencies identified by the GAO and to assist in assessing the changes identified in the previously mentioned studies, Sandia was also asked to assist AFS in improving the planning, execution, and effectiveness of the surveillance processes used to evaluate air carriers. A summary of the methods and results of that study, the Surveillance Improvement Process, follow.

¹ Flight Standards Information System (FSIS) is made up of many information subsystems. The principal subsystem for this study is the Flight Standards Automation Subsystem (FSAS) which includes Program Tracking and Reporting Subsystem, Vital Information Subsystem, and Operations Specifications Subsystem. Other FSIS components include Enforcement Information Subsystem, Accident/Incident Data Subsystem, Service Difficulty Reporting Subsystem, and others.

The Surveillance Improvement Process

Objective

The Surveillance Improvement Process (SIP) Team was formed at the direction of Mr. Thomas C. Accardi, Director of the Flight Standards Service (AFS-1), based on recommendations of the Flight Standards Service Quality Management Council. The SIP Team consisted of inspectors, other technical personnel, and managers from AFS augmented by process and safety specialists from Sandia National Laboratories. This work was supported by the Federal Aviation Administration's Airport and Aircraft Safety Research and Development Division.

The tasking of the SIP Team was to investigate and make recommendations for improving the AFS surveillance process for air carriers. The tasking is reflected in a specific recommendation (2A) of the *FAA 90 Day Safety Review*:

Initiate a project to make surveillance of air carriers more systematic and targeted to deal with identified risks. The current system should be improved by requiring comprehensive annual surveillance plans for each carrier. These plans should be managed by principal inspectors to validate their respective air carrier's systems and to target dynamically inspections throughout the year. Guidance should be provided to principal inspectors on when to reduce, or increase, planned surveillance based on safety analyses. Guidance should also be developed to link enforcement policy with targeted surveillance. ⁴

Methodology

The SIP Team worked within the framework of Process Quality Management and Improvement (PQMI), a widely recognized methodology for organizational improvement, to define the current surveillance process, determine deficiencies of the current system, identify requirements to address those deficiencies, and mold those requirements into an improved surveillance process.

The PQMI methodology is an accepted quality methodology that began at Florida Power and Light Co.; was further defined, developed, evaluated and used at AT&T; and has recently been adopted for implementation by the U.S. Navy. Other companies (such as Xerox Corporation), as well as Sandia National Laboratories, have been successful in implementing this methodology at a variety of organizational, as well as project levels.

Process Quality Management and Improvement methodology offers a structured approach to defining process goals and understanding the best way to go about achieving them. PQMI is designed to facilitate the management and improvement of existing processes, as well as the design of new processes. The methodology synthesizes quality management practices. The following principles have guided the development of the methodology:

- Process quality improvement focuses on the end-to-end process;
- The mindset of quality is one of prevention and continuous improvement;

- Everyone manages a process at some level and is simultaneously a customer and a supplier;
- Customer needs drive process quality improvement;
- Corrective action focuses on removing the root cause of the problem rather than on treating its symptoms;
- Process simplification reduces opportunities for errors and rework;
- Process quality improvement results from a disciplined and structured application of the quality management principles.

The disciplined application of the entire PQMI methodology leads to sustained process quality improvement. Benefits of this application include:

- Clarification of work priorities;
- Better coordination among the major groups working within an organization;
- Systemic identification and removal of root causes of problems;
- Prevention of problems;
- Reduced firefighting (crisis management); and,
- Achievement of quality objectives in less time, with less rework.

The PQMI methodology uses seven steps:

- **Step 1:** Establish Process Management Responsibilities
- **Step 2:** Define Current Process
- **Step 3:** Identify Performance Measures for Current Process and Goals/Requirements for the Improved Process
- **Step 4:** Assess Current Performance to Goals/Requirements
- **Step 5:** Investigate Process to Identify Improvement Opportunities
- **Step 6:** Identify Improvement Opportunities and Set Objectives
- **Step 7:** Improve Process Quality

Analysis

The team employed *system engineering* techniques, with a *system safety* focus, in analyzing the existing surveillance process. The SIP Team found a surveillance system characterized by a high dependence on individual subject matter expertise rather than an integrated and standardized set of processes designed toward achieving a coherent and well recognized goal. The current surveillance Process succeeds largely through the professionalism of the inspectors and supervisors.

Certain characteristics limit the effectiveness of the current surveillance process: there is pronounced separation among the functions of certification, surveillance, and enforcement; risk assessment is an intuitive process rather than an analytical one; lack of standardization and hindrances to communication promote individualized and uncoordinated procedures for managing certificates. Although capable and effective certificate managers are able to assess the

safety of their particular carriers, AFS has difficulty in assessing the safety of the air carrier system as a whole. It is difficult to form judgments on the relative safety of different carriers and to quantitatively justify adverse actions against a carrier.

The current surveillance system shows a lack of correlation and coordination among support functions. Training lacks timeliness and relevance in meeting the training needs of individual inspectors. Policies vary among Flight Standards District Offices (FSDOs) and from certificate to certificate. Effective feedback is lacking in many of the processes, reducing their ability to respond to changing needs. Finally, there does not appear to be any formal self assessment or independent audit function at any level in the FAA surveillance program.

Improved Surveillance Process

In developing the improved surveillance process, the SIP Team adopted a system safety approach, recognizing not only the requirement for the surveillance process to operate as a well-coordinated system, but also recognizing the necessity of evaluating an air carrier's safety systems as the most effective means of assessing safety. Resources prohibit AFS inspectors from identifying all major problems through direct observation, and emphasis on compliance to regulations, while necessary, will not ensure the highest level of safety.

Requirements for an improved surveillance system were developed around themes which addressed the identified deficiencies in the context of a system safety approach. These themes were:

- Systems Approach – Safety results from system interactions, and analysis must look at entire systems.
- Standardization – Policies, priorities, and goals must be consistent and well defined throughout the system.
- Checks and Balances – Independent assessment and self assessment are essential to improving the system.
- Communication – Information flow in both directions is essential for adequate decision making.
- Defined Action – Responsibility, accountability, and authority must be clearly defined. The objective of the surveillance process should be to have a positive influence on safety.

The improved surveillance process (ISP) which the SIP Team developed is a circular process with defined feedback avenues beginning at certification and continuing throughout the life of a certificate. It consists of the following eight principal process modules as depicted in Figure 1:

- System and Configuration
- Certificate Management
- Surveillance Resource Management
- Surveillance Implementation
- Reporting
- Evaluation

- Analysis
- Implementation

The System and Configuration process is a precursor activity which occurs during the certification process. Its recurring activity is evaluating certificate changes and maintaining the certificate configuration. This process serves two principal functions: to characterize the carrier's system for safe operation; and to develop the FAA infrastructure to manage the certificate. This process module is vital to effective surveillance planning, execution, and results analysis. It achieves the first stated goal of making the process more systematic and capable of identifying risksⁱⁱ.

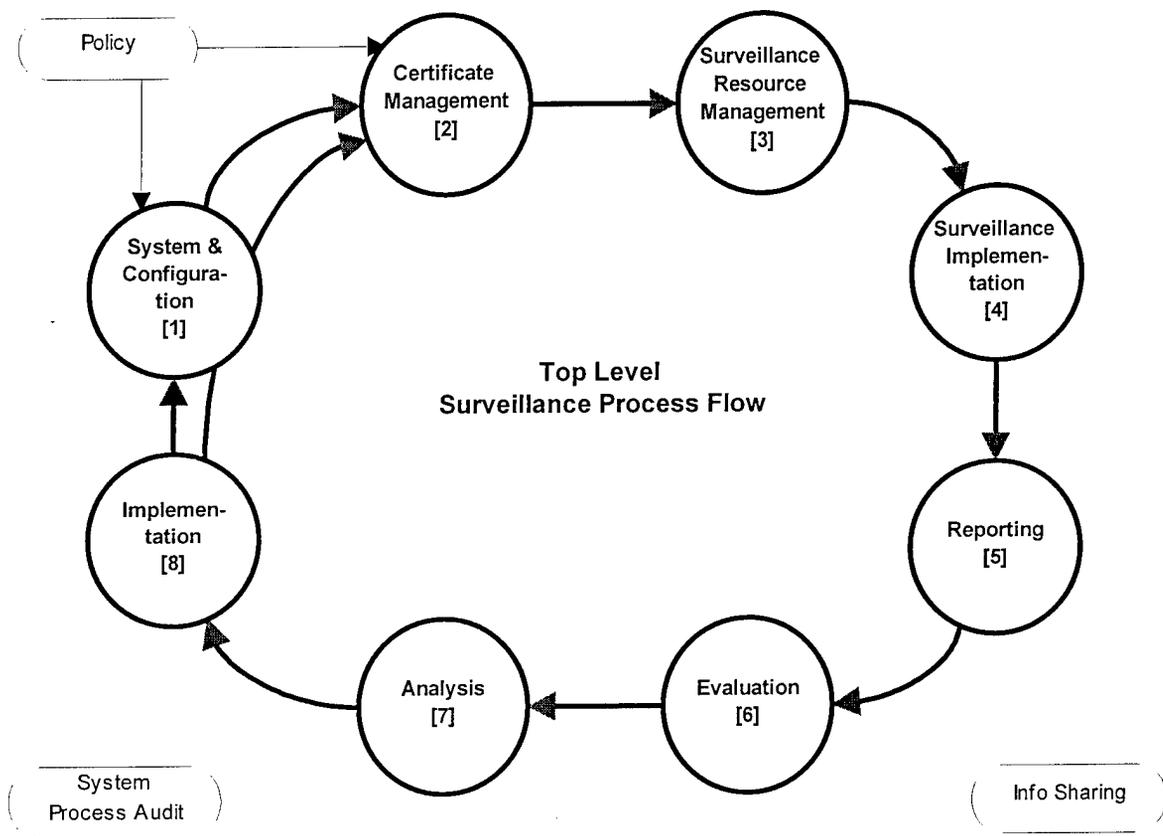


Figure 1. Conceptual drawing of the Improved Surveillance Process showing the relationship of the eight principal process modules described in the text.

ⁱⁱ The term risk is defined as the combination of the likelihood of an undesired event and its consequence. ISO 9000 defines safety as the control of risk to acceptable levels. To identify and ultimately control risk requires a system-based approach to characterize behavior. The definition of system performance measures allows meaningful sampling to detect when behavioral norms are exceeded.

The Certificate Management process achieves the next two goals of creating a comprehensive surveillance plan and allowing the principal inspectors to validate their carriers' performance. This process module is necessarily linked to other process modules within the overall process to achieve necessary inputs for planning and results feedback. An important output of this process module is an integrated surveillance plan, which is developed by the Certificate Management Team.

To allow for an integrated surveillance plan, the SIP Team identified an important concept to enable greater surveillance effectiveness, improved utilization of all inspectors, and targeting. That concept is the Certificate Management Team (CMT).

The CMT is the central group to direct surveillance, interpret results, and take appropriate action to ensure the certificate holder maintains the level of safety inherent in its certificate. The CMT comprises the collection of inspectors ranging from the principal inspector to the dispersed geographic inspectors, and it encompasses the supporting personnel. The supporting personnel include the aviation safety technicians (AST), aviation safety assistants (ASA), and analysts. The CMT concept realizes the related intent of the *FAA 90-Day Review*⁵ Recommendation 2B: "increased specialization and more efficient use of the geographic inspectors."ⁱⁱⁱ

The team approach achieves another objective of targeting surveillance. The output of the CMT is a team surveillance plan which incorporates all "R" and "P" inspections^{iv} into a single document. Changes to the plan are dynamic, based on analysis, and managed by the CMT.

Surveillance Resource Management is a logical process module that allows the FAA managers to combine work requirements with human resources. An important prerequisite to this process module is having a properly trained and qualified inspector. While not developed in this overall process, other surveillance resource support (for example, financial, material) would logically occur within this process.

Training in the current system was identified as an important process, but in the current surveillance process, it is neither fully integrated into the process nor is it adequately linked to the certificate. The SIP Team identified two levels in training development: the first is system developed needs; the second is tailoring to meet the individual's training need.

ⁱⁱⁱ Recommendation 2B (*90 Day Safety Study*): "Provide for increased specialization and more efficient use of geographic inspectors. Geographic inspectors should receive their work program from the CHDO based on the identified inspection needs. Limits should be set on the number of air carriers assigned to a single geographic inspector, and each inspector's territorial jurisdiction should be increased."

^{iv} "R" and "P" item refer to "Required" and "Planned" inspections. In the current process the principal inspector (PI) distributes the mandated inputs from the National Program Guidance to the inspectors. The PI may also create "P" items for the inspectors. The inspector then develops a surveillance plan and creates "P" items. The inspector's "Ps" are developed independently of the PI. The thrust of this recommended change is to integrate all inspections into a single controlling plan that is managed by the CMT.

Surveillance Implementation is the inspectors' process module. The process combines the work assignment from the surveillance plan, and the match-up with the individual inspector to accomplish surveillance implementation. The inspector may initiate follow-up inspections or unplanned inspections. The result is a tightly coupled inspection-to-certificate management process without sacrificing the ad hoc inspection needs. Guidance for the inspector is provided in the surveillance plan.

Reporting is a process that integrates the inspector with the FAA information management processes. An underlying area of concern has been information quality and dissemination; this module addresses that concern. The SIP Team identified an additional quality assurance element (QA) that is also consistent with the new On-line Aviation Safety Inspection System (OASIS) support. The recommendation is for daily reports to be loaded into the FSDO Local Area Network (LAN) and reviewed for data accuracy. A data quality review requires new error checking capability at the FSDO level. When the FSDO data quality review is completed satisfactorily, the completed reports would then be uploaded to the national database.

Evaluation is coupled with Reporting to ensure that good, valid information enters the surveillance process. Information is reviewed, and when errors or incomplete information are found, the reports are returned to the inspector to revise. Electronic filtering, such as available in the FAA OASIS software, provides some error checking for this activity. This is a second QA level assuring the CMT analyzes both valid and accurate information.

Analysis. Valid information is an input to the Analysis process module. For example, within the Analysis process, information is compared to carrier performance measures. A determination may be made that more detailed analysis is needed. The analyzed information is then evaluated to determine if a surveillance action is required. The output of this process is feedback to the CMT, the inspector, and other FAA entities. Any action is carried out in the Implementation process module.

The CMT analytic group may determine a need for more intensive analysis of safety related issues. With this determination, and the Certificate Holding District Office (CHDO) approval, a Safety Analysis Team is formed whose membership includes an FAA chair, the certificate holder, and others as appropriate. This recommendation will allow a closer, more proactive relationship with the carrier.

Implementation is more an outcome of the overall process than a specific process. The actions of this module may occur singly or in conjunction with others, and it is this module which achieves Recommendation 2A's goal to link enforcement with targeted surveillance policy.

The improved surveillance process, as detailed, achieves the requirements identified by the SIP Team and satisfies Recommendation 2A with the exception of developing a specific comprehensive surveillance plan. The key enhancements between the current process and this improved process are the:

- Relationship of certification and certificate management;
- Linkage between system analysis and surveillance planning, staffing, and training;
- Need to use performance measures as a basis for surveillance and for self audit;
- Creation of a certificate management team that includes the CHDO and the geographic inspectors;
- Clearer linkages between training and surveillance resource management;
- Identification of clear quality assurance measures for data;
- Creation of a defined analytic team for certificate management; and
- Relationship of the carrier in the process.

The CMT is the cornerstone to better integration of the CHDO and the infrastructure of supporting FSDOs. The SIP Team stopped short of making specific recommendations regarding the geographic inspectors. Rather, the CMT proposal offers the framework to utilize more effectively the talents of the dispersed geographic inspector work force. Through a CMT approach, the PI, the host of inspectors, and the support personnel act proactively in a coordinated fashion to dynamically manage the certificate.

The use of an integrated surveillance plan, based on system analysis, assures resources are matched to surveillance needs. The integrated plan replaces the current dispersed planning in use today. When in place, the plan is also as much the basis for human resource management as for surveillance implementation. The plan also is the vehicle to ensure inspectors have sufficient guidance to integrate their activities with the overall certificate management.

The PI is the focal point for certificate management and analysis. Today, the PI's contributions are fundamental to certificate management and the surveillance process. The ISP enhances the PI's ability to manage the certificate by providing better information through integrated surveillance planning. The ISP improves information flow in both directions between the PIs and geographic inspectors, allowing inspections to be better targeted to specific certificate management requirements and increasing the value of the information provided by geographic inspectors to the certificate manager.

By improving guidance and training for inspectors, enhancing the quality review of inspection reports, and providing better means of feedback on the inspection and reporting processes, the information obtained through surveillance will be better suited to the analysis of trends. This improved analysis will aid individual certificate managers in assessing their particular carriers. It will also significantly enhance the ability of AFS to assess the health of the commercial aviation system as a whole, including comparative assessments among similar carriers. These comparative assessments and trend analyses will allow better targeting of surveillance emphasis (both within existing certificate management organizations and through NASIP^v and RASIP^{vi} programs).

^v National Aviation Safety Inspection Program

^{vi} Regional Aviation Safety Inspection Program

¹ General Accounting Office; *Aviation Safety: Data Problems Threaten FAA Strides on Safety Analysis System*, [GAO/AIMD-95-27]; February 1995 (and earlier reports)

² Booz-Allen Hamilton, Inc.; *Challenge 2000, Recommendations for Future Aviation Safety Regulation*; April 1996; FAA Office of Policy, Planning, and International Aviation

³ Federal Aviation Administration; *FAA 90-Day Safety Review*; 16 September 1996

⁴ *ibid*

⁵ *ibid*

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