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NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

The Report of the FAA Associate Administrator for Regulation and Certification's Study of the Commercial Airplane Certification Process, *An Evaluation of Selected Aircraft Certification, Operations and Maintenance Processes, March 2002*

(14 Pages)

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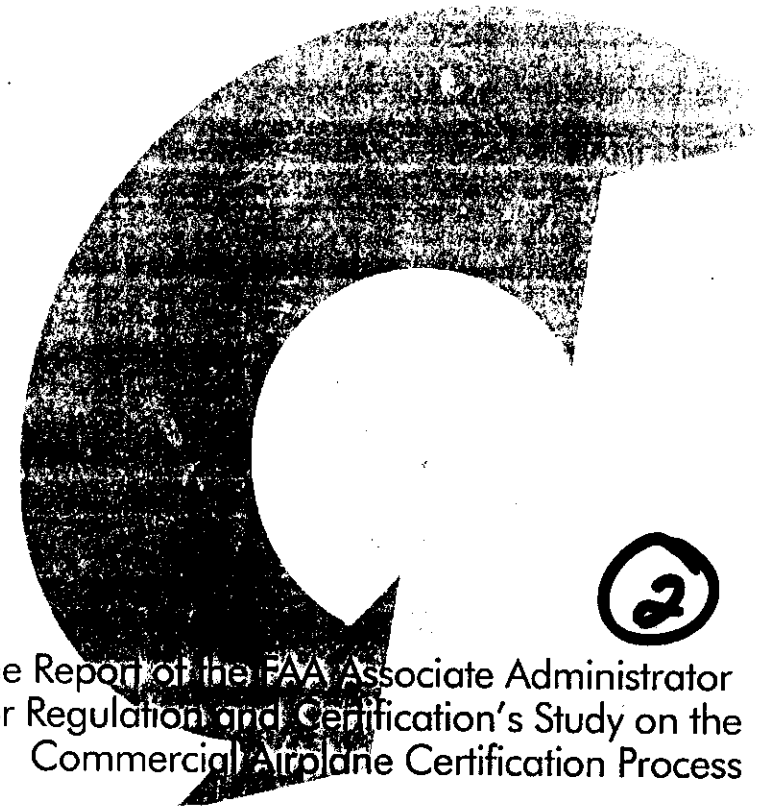
Commercial Airplane Certification Process Study

An Evaluation of Selected Aircraft Certification, Operations, and Maintenance Processes



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The Report of the FAA Associate Administrator for Regulation and Certification's Study on the Commercial Airplane Certification Process

March 2002

Executive Summary

Introduction

The safety of large transport airplanes operating in commercial service throughout the world has improved over the last several decades. Recently, this rate of improvement has slowed, as many of the major, high-impact safety improvements have been developed and implemented by the industry. However, several recent accidents have highlighted the complex nature of accident prevention and the importance of understanding and improving the processes associated with the certification, operations, and maintenance of airplanes.

In 1998, the Federal Aviation Administration (FAA) implemented the Safer Skies initiative, the goal of which was to reduce the US commercial fatal accident rate by 80 percent by 2007. This initiative has focused on using data to understand the root causes of aviation accidents and incidents in order to identify and apply intervention strategies.

As a complement to the Safer Skies initiative and to address the role that processes play in accident prevention, the FAA Associate Administrator for Regulation and Certification chartered the Commercial Airplane Certification Process Study (CPS) in January 2001. The team was led by the FAA, co-chaired by industry, and comprised of technical experts from the FAA, the US aviation industry, National Aeronautics and Space Administration (NASA), the Department of Defense (DoD), and Sandia National Laboratories, as well as representatives from a major non-US manufacturer and a non-US independent airworthiness consultant. The team was chartered to conduct a comprehensive review of the processes and procedures associated

with aircraft certification, operations, and maintenance, starting with the original type certification activities and extending through the continued operational safety and airworthiness processes intended to maintain the safety of the US commercial airplane fleet in service.

The CPS team accomplished a detailed analysis of the various processes, relationships, and life-cycle considerations. The CPS team identified five primary focus areas under which to group their findings and observations.

- Airplane Safety Assurance Processes
- Aviation Safety Data Management
- Maintenance, Operations, and Certification Interfaces
- Major Repair and Modification
- Safety Oversight Processes

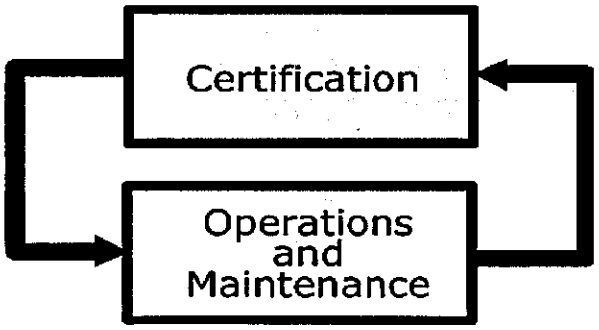

Figure 1. *CPS high-Level processes.*

The CPS effort focused on certification, operations, and maintenance processes, and the information paths between them, as depicted in Figure 1. Of special interest were the content and effectiveness of the information paths between certification and operations and maintenance activities (the arrows). Findings and observations were continuously reviewed against this diagram to ensure they were applicable to the CPS charter.

Following analysis and investigation, the team developed and documented fifteen findings and two observations.

Summary of the Findings and Observations

Airplane Safety Assurance Processes

There are many elements to safety assurance of commercial airplanes. These include the safety assessments performed to support type certification and the continuing adherence to essential operations and maintenance procedures for the life of the airplane. The design team of a new airplane must ensure that all the safety and performance requirements are met. This requires a development assurance process to track the design as it evolves. The airplane safety assessment process can be thought of as a part of this *design and development assurance* process. As with all design assurance processes, for the safety assessment process to be effective, it must trace through the entire life cycle of the product.

Human performance is still the dominant factor in accidents:

Finding 1

- *The processes used to determine and validate human responses to failure and methods to include human responses in safety assessments need to be improved.*
- *Design techniques, safety assessments, and regulations do not adequately address the subject of human error in design or in operations and maintenance.*

If significant strides are to be made in lowering the accident rates, a much better understanding of the issues affecting human performance is required. Airplane designers will be challenged to develop systems that are less error-prone. Procedures will also have to be more explicit and more robust with respect to the range of skills and techniques of operations and maintenance personnel. This area would benefit from a better understanding of lessons learned and a sharing of human engineering best practices throughout the industry.

Finding 2

There is no reliable process to ensure that assumptions made in the safety assessments are valid with respect to operations and maintenance activities, and that operators are aware of these assumptions when developing their operations and maintenance procedures. In addition, certification standards may not reflect the actual operating environment.

It will always be necessary to make assumptions in safety analyses; however, where possible, those assumptions may need to be validated by actual experience. There is currently no organized program to periodically revisit design safety assumptions to ensure that they reflect the full range of environments and operations as the fleet ages.

Finding 3

A more robust approach to design and a process that challenges the assumptions made in the safety analysis of flight critical functions is necessary in situations where a few failures (2 or 3) could result in a catastrophic event.

This finding highlights the need to examine every safety analysis assumption for its impact on the overall safety of the airplane. Where any assumption has a major effect on the outcome, the analysis and design should address the potential for the assumption being too optimistic. Risk can often be reduced by selection of a relatively conservative design approach with respect to systems with potentially catastrophic failure consequences.

Finding 4

Processes for identification of safety critical features of the airplane do not ensure that future alterations, maintenance, repairs, or changes to operational procedures can be made with cognizance of those safety features.

Changes developed without Original Equipment Manufacturer (OEM) involvement or without understanding of the original

certification assumptions add risk because the modifier, maintainer, or operator may not be aware of the criticality of the original type design feature being modified. It is difficult for operators to develop such procedures in accordance with those design constraints because only the OEM may have the detailed understanding and documentation of the underlying safety issues.

Aviation Safety Data Management

The effective management of data is crucial if the FAA and industry are to fully understand the nature of the safety challenges facing them. Data systems and sources within the FAA and industry were reviewed and analyzed. How these systems are managed and their success at meeting the needs of their customers are important indicators of their effectiveness. Finally, the data systems must provide the user with the necessary information if they are to be effective at identifying safety issues and accident precursors.

Finding 5 *Multiple FAA-sponsored data collection and analysis programs exist without adequate inter-departmental coordination or executive oversight.*

Overlapping objectives, activities, and limited resources indicate FAA data programs are not adequately coordinated. There is minimal intra-FAA data management program coordination and no clearly defined office responsible for coordinating these activities. Significant effort is underway to improve the quality of aviation safety data identification and collection. Implementing an oversight function in accordance with FAA Order 1375.1C, *Data Management* (June 20, 2001) would permit the FAA to streamline resources and programs and expand program capabilities.

Finding 6 *Basic data definition and reporting requirements are poorly defined relative to the needs of analysts and other users.*

Data are being collected in non-standardized formats and stored in multiple, often incomplete, databases. Analysis tools are usually incompatible and narrowly focused on a specific objective or product. As a result, resources are expended on multiple projects and produce separate, yet essentially equivalent products. As a result of multiple dissimilar data collection programs, associated products may not serve the aviation safety needs of government and industry.

Finding 7 *There is no widely accepted process for analyzing service data or events to identify potential accident precursors.*

Data management programs must create products and services that effectively identify accident precursors. Data collection, data mining, and analysis with automated tools to alleviate resource constraints and human error must be developed and used.

Maintenance, Operations, and Certification Interfaces

The sharing of information between manufacturers, airlines, and regulatory agencies is an essential element in the certification process and in maintaining the airworthiness of in-service airplanes. Accident and incident investigations continually focus on the breakdown in the communication paths between the members of the aviation industry as being causal or contributory to those events. These breakdowns occur as a result of either inadequate processes or the inherent constraints on communication present in the industry. Additionally, lack of formal communication processes between certain FAA organizations exist.

Finding 8 *Adequate processes do not exist within the FAA or in most segments of the commercial aviation industry to ensure that the lessons learned from specific experience in airplane design, manufacturing, maintenance, and flight operations are captured permanently and made readily available to the aviation industry. The failure to capture and disseminate lessons learned has allowed airplane accidents to occur for causes similar to those of past accidents.*

The knowledge of experienced individuals must be passed on in one form or another. This transfer of knowledge can be accomplished either formally, in documentation required by policy, or informally. However, no requirement currently exists in the FAA or in industry to ensure that the important lessons of the past are documented and used when future systems or programs are revised or developed. Without such a process, industry's memory fades and critical lessons may be painfully relearned.

Finding 9 *There are constraints present in the aviation industry that have an inhibiting effect on the complete sharing of safety information.*

The FAA has made considerable progress in reducing the constraints of legal liability, enforcement action, and public disclosure of safety information. However, the operator or manufacturer may be reluctant to fully disclose all safety information in a timely manner until complete confidentiality is guaranteed. Until this is achieved, the operator or manufacturer may elect not to contribute data out of concern for potential consequences.

Finding 10 *There are currently no industry processes or guidance materials available which ensure that*

- *Safety related maintenance or operational recommendations developed by the OEM are evaluated by the operator for incorporation into their maintenance or operational programs.*
- *Safety related maintenance or operational procedures developed or modified by the operator are coordinated with the OEM to ensure that they do not compromise the type design safety standard of the airplane and its systems.*

OEM operational or maintenance recommendations are not always fully considered by operators. Some cases have been identified where this has contributed to accidents or incidents. There have also been cases where operators, without consulting with the OEM, have modified operations or maintenance

procedures and practices that have, or potentially could have, impacted the safety of the type design. The challenge will be to identify the additional communication and reviews required to achieve a real safety benefit versus a non-productive communication requirement.

Finding 11

The absence of adequate formal business processes between FAA Aircraft Certification Service and Flight Standards Service limits effective communication and coordination between the two that often results in inadequate communications with the commercial aviation industry.

There are informal processes that have evolved between Flight Standards and Aircraft Certification, but they are neither consistent nor complete. The lack of documented formal business processes between these offices compromises timely communication and coordination that subsequently affects the FAA's ability to address industry safety issues effectively and industry's ability to comply fully.

Major Repairs and Modifications

Once the manufacturer releases an aircraft to an operator, the operator is responsible for maintaining its continued airworthiness. Maintaining continued airworthiness involves routine maintenance, as well as repairs and alterations to the aircraft. For all of these activities, an approved configuration must be maintained. Maintenance, repair, and alteration work is accomplished using either FAA approved or accepted data, including operator and manufacturer documents.

Finding 12

The airline industry and aircraft repair organizations do not have a standardized process for classifying repairs or alterations to commercial aircraft as "Major" as prescribed by applicable Federal Aviation Regulations (FARs).

There is no standard process used across the commercial aviation industry or regulatory authority to determine and classify

repairs or alterations to commercial aircraft as "Major" as defined by applicable FARs. The result of misclassifying a repair or alteration is the lack of adequate review, validation, and reporting of the sufficiency of repairs or alterations developed.

Finding 13

Inconsistencies exist between the safety assessments conducted for the initial Type Certificate (TC) of an airplane and some of those conducted for subsequent alterations to the airplane or systems. Improved FAA and industry oversight of repair and alteration activity is needed to ensure that safety has not been compromised by subsequent repairs and alterations.

Processes for the design and accomplishment of repairs and alterations, including oversight, have not always ensured the continued airworthiness of the airplane. Safety assessments prepared for certification of alterations to the airplane or systems may not meet the same standards as those for the original type certificate, although the FARs require they do so. There have been cases where the modification station or company did not have the appropriate expertise or access to original certification data to conduct adequate safety analyses.

Observation 1

OEM and operator's maintenance manuals, illustrated parts catalogs (IPC), wiring diagrams needed to maintain aircraft in an airworthy configuration after incorporation of service bulletins (SB) and airworthiness directives (AD), are not always revised to reflect each aircraft's approved configuration at the time the modifications are implemented.

Maintenance manuals, IPCs, wiring diagrams, and other FAA accepted or approved manuals are required for continued airworthiness. Incorrect data as a result of delayed revisions to user manuals can result in the release of an aircraft into service in a non-airworthy configuration. A process is needed to adequately assure that proper repairs and modifications are implemented and mandated configurations are not altered. All manuals and documents that are needed to support the correct implementation of ADs, Alternative Methods of Compliance (AMOCs), Supplemental Type Certificates (STCs) or other authorized documents should be revised to reflect the mandated

aircraft design configuration in order to assure continued airworthiness.

Safety Oversight Processes

FAA and industry oversight of the design, manufacture, and operation of commercial aircraft involves a large number of tasks. These oversight tasks are often the basis for the discovery of information used to establish safe practices and processes. Oversight also serves as a means to assess the adequacy of existing standards and requirements. Strong and effective industry and FAA oversight processes can be used to identify potential safety problems and accident precursors. Making improvements in this area can further enhance the present exceptional commercial aviation safety record.

Finding 14 *Consultant DERs have approved designs that were deficient or non-compliant with FAA regulations.*

The DER system is generally working well, but still needs emphasis. This system has been enhanced by the addition of new processes for selection and annual review of DERs. However, some consultant DER project approvals, which do not require FAA review, have resulted in designs that were deficient or non-compliant with FAA regulations because of a lack of DER and FAA technical expertise in certain specialized fields.

Finding 15 *Processes to detect and correct errors made by individuals in the design, certification, installation, repair, alteration, and operation of transport airplanes are inconsistent, allowing unacceptable errors in critical airworthiness areas.*

For some certification activities there are well-ordered and effective processes; for others, no formal process exists, or existing processes may be ineffective. When there has been a lack of an effective process, individuals working independently have made errors in critical airworthiness areas; some of these errors have resulted in accidents.

Observation 2 — *Some air carriers do more extensive oversight than others of their in-house and outsourced flight operations and maintenance activities, with major safety and economic benefits.*

Briefings provided by large Part 121 certificated air carrier personnel indicated that when voluntary internal quality assurance and technical analysis processes are used, significant safety and economic benefits could be realized. The effectiveness of these processes was substantiated in interviews with FAA principal inspectors with maintenance and operations oversight responsibilities. The FAA should encourage all segments of the air carrier industry to enhance their existing processes. It has been suggested that FAA incentives could be considered to influence others in the aviation community to enhance internal and external quality assurance and technical analysis activities.

Conclusions

Several key conclusions were drawn from the study. First, the findings and observations in this study were found to be interrelated. For example, the team identified four areas of commonality:

- Information Flow
- Human Factors
- Lessons Learned
- Accident Precursors

Although other common elements could be identified and documented, the key conclusion is that the findings and observations in this study are clearly interrelated and should not be addressed in isolation. Doing so will most likely lead to less than optimal solutions.

Second, many of the accidents reviewed during this study followed one or more previous incidents that were not acted

upon because those involved in industry and government were unaware of the significance of what they had observed. Often the reason for this lack of awareness was failure to view the significance of the event at the *airplane level*, rather than at the system or subsystem level. Safety awareness at the airplane level is needed for all key safety specialists, regardless of their organization, and is achieved by both proper training and adequate experience. Safety initiatives could be better coordinated and more effective if the operator, manufacturer, and FAA could achieve and maintain this level of safety awareness.

Finally, traditional relationships among the regulators and industry have inherent constraints that have limited the ability to effectively identify accident precursors. Further safety improvements will require significant intra- and inter-organizational cultural changes to facilitate a more open exchange of information. Process improvements alone will not improve safety unless the leaders of government and industry and their respective organizations are committed to working together to achieve this goal of cultural change.