ASSEMBLY — 36TH SESSION

TECHNICAL COMMISSION

Agenda Item 29: Flight Recorders

AN OUTLINE OF THE DEVELOPMENT OF WORK ON FLIGHT DATA RECORDER SYSTEMS

(Presented by the United States of America)

EXECUTIVE SUMMARY	
This paper presents an outline of the work that has been accomplished in the United States to advance the quality, reliability and technical capabilities of current and future flight data recorder systems.	
Strategic Objectives:	This working paper relates to Strategic Objective A.
Financial implications:	Not applicable.
References:	

1. INTRODUCTION

1.1 Over the last decade, the United States Federal Aviation Administration (FAA) has taken a series of coordinated actions to update the standards for flight recording systems. The FAA is committed to ensuring that domestic and international aviation safety agencies have the necessary tools to assist in their accident and incident investigations. This paper provides a brief description of recent accomplishments and future work that the FAA is planning to foster the development of flight recorder technologies.

2. DISCUSSION

2.1 The FAA has participated in many activities directed towards improving the quality, quantity and reliability of data recorded in crash protected memory for use in accident and incident investigation. The FAA is promulgating several rulemaking activities. The FAA has worked with industry groups to 1) develop technical standards to establish new Technical Standard Orders (TSOs) for recording systems and 2) test and better understand the potential use of new recording technologies. A description of each of these activities is provided in the following paragraphs.

2.2 **Rulemaking Activities**. The FAA is currently in the process of promulgating two rulemaking activities that are aimed at improving the quality, quantity and reliability of flight recorder data.

2.2.1 **Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR) Improvements Notice of Proposed Rule Making (NPRM).** In February 2005, the FAA released an NPRM that if adopted, would make several improvements to the quality, quantity and reliability of the current flight recorder system's data. The rulemaking is a result of technical assessments of accidents, such as Alaska Airlines Flight 261, SwissAir Flight 111, Egypt Air Flight 990, and American Airlines 587 and in response to National Transportation Safety Board (NTSB) safety recommendations. The rule would require that two years after the effective date of the rule, operators and aircraft manufacturers must accomplish the following:

- All airplanes that are required to carry a CVR must retrofit their airplanes to install a two-hour, solid-state recorder. This eliminates the use of magnetic tape and 30 minute solid state recorders which were raised as a concern in A35-WP/144. Also all newly manufactured airplanes and rotorcraft that are required to carry a CVR, must install a two hour, solid-state recorder.

- All newly manufactured aircraft that are required to carry a CVR, must install an independent power supply capable of providing 10 minutes of back-up power to the CVR in the event that normal aircraft power is lost.

- All aircraft that install certain types of data link communications equipment (as specified in the associated advisory circular), must record air/ground messages both received and generated by that equipment.

- All newly manufactured aircraft that are required to carry a CVR or FDR, must incorporate design changes to ensure that no single aircraft electrical power failure will remove power to both the CVR and FDR.

- All newly manufactured aircraft that are required to carry a FDR must increase the sampling rates of flight control input and position parameters.

2.2.2 **Flight Data Recorder Filtering Rule.** In November 2006, the FAA released this NPRM to specifically address the FDR data filtering issues found during the investigation of American Airlines accident over Jamaica New York (AA 587). During the investigation of the accident, the NTSB determined that the rudder control surface position data recorded by the FDR was filtered before being recorded. The filtering of the data made it impossible to accurately determine the actual rudder movement. Post accident testing and analysis, including application of a reverse filter to the recorded data helped investigators determine the approximate position of the rudder, but the distance the control surface actually moved is still unknown.

2.2.3 When the 1997 FDR Expanded Parameter rulemaking was promulgated, the FAA established the requirements for the current 88 mandatory FDR parameters. These requirements included specification of the range, rate, resolution and accuracy of each parameter. The intent was that these specifications apply to the parameters in both static and dynamic conditions. The United States believed that it would be impossible to record filtered parameters and still meet these requirements. The United States determined from the findings of the AA587 accident that we need further clarification of the regulations. As such, the FAA proposed rulemaking to prohibit filtering of certain flight control input and flight control surface parameters.

2.3 **Industry Recorder System Standards Development**. The FAA has actively supported the development of various flight recorder standards. The FAA participated in the development of the Eurocae Document, ED-112, “Minimum Performance Specification for Crash Protected Airborne Flight Recorders”. This document defines the performance standards for CVRs, FDR, CNS/ATM (Datalink) and Image recorders, as well as requirements for combining multiple recorder functions within the same unit and specifications for recorder independent power supplies. After the final release of this document, the FAA revised and released new TSOs that adopted this specification as the Minimum Performance Standards for the following recorder systems components:

- TSO-C123b - Cockpit Voice Recorder Equipment
- TSO-C124b - Flight Data Recorder Systems
- TSO-C155 - Recorder Independent Power Supply
- TSO-C176 - Aircraft Cockpit Image Recorder Systems
- TSO-C177 - Datalink Recorder Systems

Among the many benefits gained by adopting ED-112 as the MOPS for crash protected recorders, this changes also addresses one of the specific concerns raised by A35-WP/144. All new recorders produced under these TSOs will have locator beacon attach mounts that are tested to ensure that the beacons remain attached when they are subjected to the same impact shocks as the memory modules. This should ensure that the beacons remain attached to the recorders under any circumstances where the memory module is expected to survive.

2.3.1 In addition to these activities, the FAA participates in several ARINC working groups that are developing ARINC Characteristics and Specifications for the following recorder system components:

- ARINC Characteristic 767, "Enhanced Airborne Flight Recorder (EAFR)", which provides the form, fit and function requirements for a combined flight recorder.

- ARINC Specification 647, "Flight Recorder Electronic Documentation (FRED)", which provides a standardized data documentation format.

- ARINC Characteristic 777, "Recorder Independent Power Supply", which provides form, fit and function requirements for various power supply configurations.

- ARINC Characteristic 757, "Cockpit Voice Recorder", which provides form, fit and function requirements for CVR system components.

2.3.2 The FAA is also working with the newly formed ARINC working group that is developing the specifications for a new FDR recorder data-stream format that will be used in avionics architectures that use local area network (LAN) connectivity. We are also working with the NTSB to develop a FRED editor that will be made available to the industry at no charge, to encourage a standardized industry.

2.4 I**mage Recorder Proof-of-Concept Testing**. In July 2005, the FAA conducted testing with the NTSB and two image recording component manufacturers. The FAA accomplished this proof-of-concept test to determine the effectiveness of using recorded images for post accident or incident investigation. The images were used to derive parametric aircraft performance data as well as ascertain general conditions within the cockpit and the condition of the crew.

2.4.1 The testing involved the interim installation of cameras and image recorders in a FAA Beech King Air airplane. The recorder was crash protected and was capable of storing two hours of image information. The camera used was designed to provide a clear picture of the flight deck instrumentation and had resolution sufficient to read instruments and indicators. During the test, the airplane was operated in specific flight scenarios. Once the FAA recorded all flight scenarios, we downloaded and transcribed the images into a format suitable for accident investigation and analysis. The NTSB derived as many of the 88 mandatory FDR parameters as possible from the images and tried to meet the range and accuracy requirements of the regulations. The NTSB accident investigation authorities used this data for detailed parametric and crew performance analysis. Once the NTSB completed the analysis, the investigators compared this data with actual flight data recorded on the FDR installed on the test aircraft.

2.4.2 The results of the test were favourable. The NTSB derived 51 parameters from the recorded images and in most cases, did so within the parameter range and accuracy tolerances of the regulations. In fact, the data from the images identified a FDR altimeter data correlation issue. However, the test did reveal several challenges associated with image recording. The FAA had difficulty finding a single camera installation that operates within the tolerances of ED-112. In order to comply with ED-112 resolution requirements, our test would have had to install four to five cameras at various locations in the flight deck. The FAA also had difficulty meeting the stringent lighting condition requirements of ED-112. Another challenge was in the analysis of the images. Deriving the parametric data from the recorded images was very time consuming. It took several weeks for the NTSB investigators to derive the 51 parameters they obtained, from five minutes of image recording.

2.4.3 The conclusion the FAA has drawn from this test is that use of image recording for deriving parametric data for post accident/incident investigation is promising, but additional testing and analysis must be done before this technology is mature enough to be installed for this specific purpose.

2.5 **FAA Flight Data Analysis Capability**. One of the challenges in FAA is our inability to download and readout FDR data. The ability to perform these functions would be invaluable in helping us in certification and operational approval of FDR systems and in analysis of accidents and or incidents. To address this challenge, the FAA has begun a new program to develop FDR readout capability.

2.5.1 To address the challenges of certification and operational approval of FDR systems, the FAA is developing a "DFDR Validation Program". In this program, the FAA will develop Partnership for Safety Plans with airlines and aircraft manufacturers to obtain the information necessary to download and read-out the FDR recorded data. The FAA has obtained the tools and is working with the NTSB and the industry to develop the skills to accomplish this task. The primary task in the program is to validate the DFDR system data correlation documentation or "data-map". Working with the airlines and the manufacturers, the FAA will obtain the various data-maps for the new and existing aircraft models and types. The FAA will validate the data-maps by checking the conversion algorithm documentation against a sample of DFDR recorded data from one of the recorders. The converted data will be checked to ensure that the range, rate, resolution, and where possible, the accuracy of the parameters are within the tolerances specified by the regulations. Once the validation is complete, the sample data will be discarded, but the FAA will retain a copy of the validated data-map. The FAA intends to build a repository of validated data-maps that covers the majority of the aircraft in operation. By doing this activity, the FAA hopes to proactively identify and resolve data problems such as incorrect resolution, recording rates, stale data and possibly even data filtering before an incident or accident occurs where identification of such problems can severely hamper the investigation.

2.6 **Challenges to Implementation**. Mandating retrofit of flight data recorder changes is very difficult. From an operator's perspective, with limited modification funds it is hard to justify the benefit of installing enhanced flight recorder capabilities on existing aircraft when compared to the costs of the modification. Comments to FAA's current recorder rulemakings show that the industry feels that the limited funds they have should be used for incorporation of modifications that address direct safety concerns. From these comments, the industry consensus is that the time to install new or enhanced recorder technologies is during new type design or new aircraft manufacture.

3. CONCLUSION

3.1 Continuous work is being done in the industry to advance flight recorder technologies. With these new recorder technologies, increased crash protected memory capacity and newly developed data collection formats, the flight recorder of tomorrow will provide accident investigators with more detailed information than ever available before. The challenge is to get these new developments installed on both new and existing aircraft. U.S. industry believes that the costs of enhanced flight recorder capability outweigh the safety benefits for the existing fleet. Therefore it is important for States to weigh industry concerns when deciding the aircraft applicability of any new flight recorder regulation. ...

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