TECHNOLOGY WHITE PAPER

Optimizing Flight Data Recorder Modification Requirements

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DEFENSE SOLUTIONS

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Flight Data Recorders

Cockpit Voice Recorders

Data Link Recording

Image Recording

History of Flight Data Recorders

Aircraft Sustainment

Integrated HUMS

Introduction

Cockpit Voice and Flight Data Recorders (CVFDR's) are necessary for many aircraft to provide valuable information to accident investigators following an incident. Often modifications are required to meet an aircraft's interface requirements, current regulations or to accommodate additional data for other applications. Such modifications may be costly or can require additional LRUs to fulfil requirements due to the high cost of modifying safety critical equipment. This white paper will discuss how, using modular design methods, modifications can be simple and how the resulting inbuilt functionally can help reduce costs and lower overall weight and space requirements.

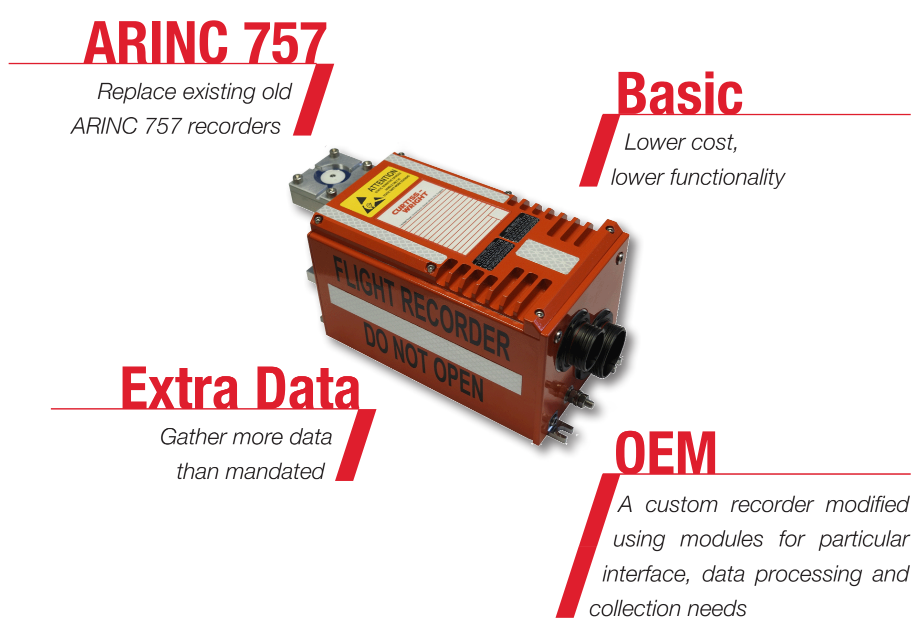

Figure 1: Not everyone needs the same CVFDRs – almost every recorder ends up being custom to some extent

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Evolution of Flight Data Recorders

CVFDRs sometimes called ‘black boxes’, are invaluable tools for accident investigators to help determine what has happened following an incident. They typically gather flight data, cockpit voice and datalink messages and are constructed in such a way that they can survive extreme environmental conditions such as high impacts and long exposure to high temperatures. For many years, most large commercial aircraft have been mandated to have one or more recorders installed. Today, many aircraft choose to install them even when there is no requirement, simply for safety and maintenance reasons.

The first flight data recorder (FDR) is attributed to Dr. David Warren in 1954 who conceived the idea while investigating a mysterious crash. In 1955, Professor Penny and Mr. Giles created the first magnetic FDR. In 1960, FDRs start spreading into more and more aircraft and in 1963 the UK ministry of Aviation mandated that all civil carriers must carry one.

Since then, FDRs have been mandated on most civil carriers around the world and the regulations concerning features and environmental specification are still evolving to help improve safety within the industry. The most recent regulation changes are in reaction to recent incidents where finding downed aircraft took an excessive amount of time. This includes new regulations for Underwater Locator Beacons (ULB) to test for sheer and tensile strength, and to increase the transmission duration from 30 to 90 days. Also on the horizon is the EASA requirement for airplanes with a Maximum Certified Take-Off Mass (MCTOM) of more than 27,000 kg (59,500 lb) to have a CVR recording duration of 25 hours.

While such changes in regulations help improve flight safety for everyone, it also means that older designs of CVFDRs are not suitable for most new or retrofitted aircraft. This can incur cost as CVFDRs usually need alterations to meet new regulations and the high requirements for safety and environmental protection mean that even a small change can be very costly to make.

Aircraft system designers are continually looking for ways to reduce the size and weight of avionics equipment. This is especially true for smaller aircraft where space is at a premium, although even larger aircraft are cognizant of how every extra pound has an impact on fuel burn or how every few square inches could be used more productively. Every extra piece of equipment adds weight and must justify its fuel and space cost.

Operators also tend to look for ways to enhance operational readiness, improve flight efficiency, increase safety and reduce maintenance costs. CVFDRs are now being recognized as storage solution for many avionic applications.

Meeting Interface Requirements

There are many CVFDRs on the market, but while most will meet aviation requirements, any choice of recorder may need some level of modification for a specific aircraft. This modification may be as simple as changing mounting brackets to as complex as a redesign to meet new crash survivability regulations. However, often the aircraft has data in a format incompatible with the recorder on offer, or an operator wants other parameters included in the recording. Small changes can result in a requirement for a lot of work. Modifications to a product can cause delays, as some level of qualification testing will be needed to ensure the recorder still meets current and future requirements.

A common approach is to use an intermediary unit to gather the required data and send it to the recorder in a compatible data stream. This Flight Data Acquisition Unit (FDAU) needs to connect to various sources of information on the aircraft, such as avionics busses, and to additional sensors to gather, process and, perhaps, store the data. Additional data can then be transferred post flight using removable storage devices or by downloading via a standard interface (Ethernet, USB etc.) for use in monitoring and operational applications such as Health and Usage Monitoring (HUMS), Flight Operational Quality Assurance (FOQA) and Flight Data Monitoring (FDM).

These units can be off-the-shelf solutions, custom built or a combination of both (modified COTS). While such products have a proven track record of meeting application requirements, they are typically packaged as stand-alone units and thus take up space, add weight and increase installation and logistics overheads.

Meeting Future Regulations

Regulations change over time and while these are generally not retroactive, it makes sense to use recorders that have been future proofed. This can help to minimize any need to upgrade if a new technology is implemented on the aircraft that has a requirement for recording, or can reduce the risk of needing a new recorder system if there is a significant change such as a cockpit upgrade. The more commonality between equipment across a fleet, the easier it is to manage equipment logistics, training and software requirements.

Future proofing any electronics is difficult and only possible in the short to medium term due to the rapid pace of change of regulations and the emergence of disruptive technologies. However, change does tend to happen more slowly for CVFDRs as it can take years for regulatory bodies to formulate recommendations and implement them as mandated requirements.

By closely following developments made by regulatory bodies and changes in aviation technology, it is possible to anticipate many future requirements and introduce features in a CVFDR to accommodate future unknowns. An example is ensuring compatibility with certain systems to anticipate potential future integration with transmission systems. This can add to the cost of the recorder, and is functionality that is more likely to be outsourced to an FDAU where possible.

Integrating an FDAU Functionality Into an FDR

Another approach is to integrate an FDAU into a CVFDR. Thanks to the continual reduction in size and the increased speed of modern electronics, it is now possible to pack a huge amount of capability in a small volume. The first iPhone was introduced in 2007 – 10 years prior to this paper being authored. The increased functionally in just 10 years is testament to how quickly electronics have evolved and how much processing power can be fitted into a small volume.

The critical component of a CVFDR is the crash protected memory. The crash tube protects it, and its size is constrained by physics. In order for the crash protected memory to survive sustained temperatures of 1,100°C for an hour and 240°C for 10 hours, there has to be a certain thickness of heat protecting material. Similarly, to survive impact shock and penetration resistance, it needs be designed using metals thick and strong enough to survive the corresponding survivability test requirements. These factors contribute the fact that it adds little weight or takes up relatively little extra space, to add far more complex and useful electronics inside a crash survivable recorder.

CVFDRs can now be designed to accommodate modular plug-in boards that can add extra functionality to standard ARINC 717 and CVR recorders. The advantage of this is that only the daughterboard requires qualification when functional changes are required or extra data acquisition or processing capability is needed. Testing modules is less time consuming than testing a new motherboard which enables quick time to market. It can also means the cost of purchasing and installing an FDAU is removed as the CVFDR's can take on its functionality, saving additional weight and space.

Modular FDR Electronics

Curtiss-Wright, through the acquisition of Professor Penny and Mr. Giles' company (Penny & Giles), has 60 years of experience designing and manufacturing CVFDRs. We have been keen to design solutions so our CVFDRs can adapt quickly to meet aircraft needs, protect against future regulations and facilitate additional data acquisition and processing.

Our latest CVFDR is the Fortress. It is designed to provide more flexibility, for everything from where the unit is mounted to what kind of interface is used, while making data retrieval faster and easier and keeping maintenance costs to a minimum. There are several Fortress variants – the Fortress OEM being specifically designed to quickly meet applications that require extra data acquisition, processing capability or other custom applications such as 1553, encryption and FDAU functionality.

Figure 2: Fortress OEM takes the most modern recorder design and allows custom functionality to be added quickly and easily

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Fortress OEM provides an aircraft a recording solution supporting custom data acquisition as well as parametric flight data, 4 channels of cockpit voice recording and CPDLC recording for up to 25 hours each and image recording for a minimum of 2 hours. Through the provision of an expansion slot with internal interface to the Fortress processor card, Fortress OEM can be adapted to support different interface and functional requirements. One such example is the inclusion of Health and Usage Monitoring capability. Other examples include data/audio encryption capability and different bus interface support.

Fortress OEM is designed in accordance with RTCA/DO-178C and RTCA/DO-254. It meets all current and anticipated FAA and EUROCAE requirements and has a 90 day ultrasonic locator beacon (ULB), certified to TSO-C121b and is currently the newest, most highly functional and easily customizable Cockpit Voice, Flight Data and Image Recorder on the market.

Problem-Solution Summary

Many aircraft need CVFDRs to meet regulatory requirements. Often it is not possible to get an off-the-shelf solution that will slot into the aircraft system without modification. Changes in regulations and the desire to gather more data can result in managing different CVFDRs across fleets and in multi-box solutions. One solution is to design CVFDRs with the ability to house data acquisition and processing modules and to accommodate anticipated future regulation changes. This is precisely the design philosophy behind Curtiss-Wright's Fortress OEM.

Learn More

Product Information:

Fortress HUMS

Blog:

Adding Functionality While Lowering Certification Costs

Case study:

Flight Recorder Delivers SWaP-C Benefits for Legacy Avionics Systems

Video:

Flight Data Recorder Interview

White Paper:

Addressing Safety and Maintenance Concerns without Increasing LRU Count