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4.2 Action Required

4.2.1 Fuel Leak Detection and Warning

Indications and warning systems should be designed to detect critical events, to provide unambiguous information on critical situations with high risk, and to direct crews to specific actions that would mitigate these risks. Clear indications and warnings are particularly necessary for high-risk, rare events, situations that are difficult to diagnose, and situations that require precise handling, in particular under conditions of high workload and stress.

Historically, fuel leaks were considered to be rare events, and although consequences could be significant, the overall risk was evaluated as being low. It was also considered that routine fuel quantity monitoring and common sense would drive a crew to a prompt precise determination of the cause of the symptoms and to take the required action. The historical occurrence records indicate that, although in-flight fuel leaks are infrequent events, these events continue to occur. Recent occurrences have revealed that crews have had difficulty in diagnosing fuel leak situations, and that the consequences can be significant.

Analyses of past events have resulted in the design and implementation of systems capable of detecting fuel loss events and of alerting crews, and in the creation specific fuel leak checklist procedures. Some civil aviation authorities have mandated the implementation of these capabilities and checklist procedures.

In this occurrence, the crew's routine monitoring did not detect that a fuel leak was occurring until over 6 tons of fuel had been lost. Also, the low-level nature of the Fuel ADV, on its own, did neither clearly indicate the cause of the imbalance nor the severity of the situation that existed.

Although the Airbus A-330 Flight Warning Computer has a FUEL FU/FOB DISCREPANCY Caution alert capability, the implementation of this system capability has neither been mandated for all Airbus A-330 aircraft nor for other Airbus aircraft of similar fuel system design.

Therefore, it is recommended that Direction Générale de l'Aviation Civile of France:

- *Mandate the implementation of the FUEL FU/FOB DISCREPANCY Caution alert for all A-330 aircraft; and*
- *Mandate the incorporation of a fuel loss alert for other Airbus aircraft with similar fuel system design.*

SAFETY RECOMMENDATION AA/2004

It is also recommended that the civil aviation authorities of other transport aircraft categories manufacturing states, such as Canada, United States of America, and United Kingdom, as well as the European Aviation Safety Authority:

- *Review the adequacy of aircraft indications and warning systems and procedures to detect fuel-used/fuel-loss discrepancy situations;*
- *Review the capability of these systems to provide clear indications as to the causes of these situations; and*
- *Review the capability of these systems to provide alerts at a level commensurate with the criticality of a fuel-loss situation.*

SAFETY RECOMMENDATION AB/2004

4.2.2 Fuel Leak Training

Training is the fundamental approach to ensuring that crews remember/recall, and can easily assimilate symptoms with a required procedure. Training also ensures more accurate completion of the procedure designed to mitigate a given situation, in particular for a rare event, or for situations of high workload and stressful situations.

As a result of previous similar occurrences, fuel leak checklists had been created or improved, and some limited documentation had been added to flight manuals regarding the criteria to be used to determine if a fuel leak exists. Notwithstanding, prior to this occurrence, no or very little training was provided to crews on fuel leak situations. This deficiency is not unique to this A330 operator or to other Airbus operators having similar fuel and flight management systems. For this particular occurrence, had the flight crew members been trained in the symptoms of fuel leak situations and strategies to identify and counter such a situation, they would have been better prepared to take appropriate actions.

Although since this occurrence, some civil aviation authorities and aircraft manufacturers have taken action to improve related checklists and to improve crew awareness of the critical nature of fuel leaks, there are a number of commercial aircraft that do not have identification procedures or fuel leak checklists. There are also no specific regulatory requirements for training on fuel leak scenarios.

The historical occurrence records indicate that, although in-flight fuel leaks are infrequent events, these events continue to occur. The dissemination of information related to this occurrence will enhance safety by increasing crew awareness of the fuel leaks in the short term. Notwithstanding, ensuring safety in the longer term will require other sustained action to ensure that crews are better prepared for these events.

Therefore, it is recommended that Direction Générale de l'Aviation Civile of France, Transport Canada, Civil Aviation Authority of the United Kingdom, the Joint Aviation Authority, European Aviation Safety Authority, and the civil aviation authorities of other states:

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- Review flight crew operating manuals and checklist procedures to ensure that they contain adequate information related to fuel leak situations;
- Review flight crew training programs to ensure that they adequately prepare crews to diagnose and take appropriate actions to mitigate the consequences of fuel leak events; and
- Amend regulations and standards to require crew training on fuel leak events.

SAFETY RECOMMENDATION AC/2004

It is also recommended that, as an interim safety measure, all civil aviation authorities:

- *Promulgate the circumstances of this fuel leak event to all air operators, aircraft manufacturers and flight crew training organizations.*

SAFETY RECOMMENDATION AD/2004

4.2.3 Automated Fuel Transfers

As evidenced in this occurrence, the automated transfer of fuel from the trim tank to the right wing tank and subsequently to the leak in the right engine resulted in over 3.2 tons of fuel being lost. Although the trim tank transfer memos were displayed to the crew, these memos did not reflect the seriousness of the abnormal transfer of a significant amount of fuel to only the set of wing tanks on one side of the aircraft. This transfer also contributed to masking the fuel leak problem from the crew.

Therefore, it is recommended that Direction Générale de l'Aviation Civile of France, in consultation with Airbus:

- *Review the automated, fuel-transfer systems on Airbus aircraft to ensure that the systems are able to detect abnormal fuel transfers, that systems exist and procedures are in place to inhibit abnormal transfers, and that the crews are notified, at an appropriate warning level, of abnormal fuel transfers.*

SAFETY RECOMMENDATION AE/2004

4.2.4 Significant Fuel Imbalances

As evidenced in this and many other occurrences, significant fuel imbalances between wing tanks would most likely occur if there were a significant fuel leak. It is also apparent that, in such situations, directing crews using a FUEL ADV and the information on the Fuel page to a FUEL IMBALANCE checklist may not provide a definitive indication that a serious fuel leak could exist. Not immediately focussing crews to the probable existence of a fuel leak and to the indications that could be used to interpret the source of the leak has the potential to delay the critical actions required to mitigate the consequences of a fuel leak.

Therefore, it is recommended that Direction Générale de l'Aviation Civile of France and EASA:

- *Review Airbus aircraft indication and warning systems and abnormal procedures to ensure that, in situations of major fuel imbalances, actioning of appropriate fuel leak procedures becomes a priority for flight crews; and*
- *Consider merging the Airbus FUEL IMBALANCE and FUEL LEAK checklist procedures into one procedure, containing, at the top of the procedure, the conditions that would suggest the presence of a fuel leak.*

SAFETY RECOMMENDATION AF/2004

It is also recommended that the civil aviation authorities of other aircraft manufacturing states, such as Canada, United States of America, and United Kingdom, as well as the European Aviation Safety Authority:

- *Review the adequacy of the fuel indications and warning systems, as well as procedures associated with fuel imbalance situations to ensure that the possibility of a fuel leak is adequately considered.*

SAFETY RECOMMENDATION AG/2004

4.2.5 Safeguarding Recorders

As evidenced in this occurrence, although the crew was aware of the requirement to safeguard the on-board recordings before powering up the aircraft, 90 minutes of the CVR recording was overwritten. In fact, the lack of documentation readily available to the crew regarding the deactivation of the flight recorders led to the inadvertent disabling of the recorder overwriting protection feature installed on the aircraft. The historical record indicates that there have been many occasions when CVR recordings have been lost due to not disabling power to CVR's.

Although Canadian Commercial Air Service Standards and the Transport Canada approved Air Transat Operations Manual state that there is a requirement to preserve recordings following an occurrence, there was no specific information, diagrams or procedures readily available to the crew as to how the preservation was to be accomplished.

Although NTSB Recommendation A-02-24 "Overwritten Cockpit Voice Recordings", issued on August 29, 2002, recommended that improved information and checklists be available to crews to preserve recordings, actioning of the recommendation by the Federal Aviation Administration would only affect air operators certified to conduct operations in the United States of America.

Therefore, it is recommended that Transport Canada and Direction Générale de l'Aviation Civile of France and EASA:

- *Review the adequacy of applicable regulations, standards and aircraft manuals to ensure that necessary information and guidance is made available to the crews to properly safeguard on-board recordings following an occurrence.*

SAFETY RECOMMENDATION AH/2004

It is also recommended that the civil aviation authorities of other states, as well as the European Aviation Safety Authority:

- *Review the adequacy of their regulations related to the safeguarding of on-board aircraft recordings.*

SAFETY RECOMMENDATION AI/2004

4.2.6 Recorder Power Sources

Although the loss of flight recorder information for the last 19 minutes of the engines-out descent and landing on this occurrence did not adversely affect the investigation to this occurrence, had the circumstances been different, the lack of data following the power loss on both engines could have severely affected the ability of the investigation to make findings as to the causes and contributing factors to this occurrence.

Although previous recommendations have been issued by aviation safety investigation authorities, and these recommendations are being considered by individual civil aviation authorities and international standards organizations, the Gabinete de Prevenção e Investigação de Acidentes com Aeronaves (GPIAA), the accident investigation authority of Portugal, remains concerned regarding this deficiency.

Therefore, it is recommended that the European Organization for Civil Aviation Equipment, ICAO, all civil aviation authorities and safety investigation authorities:

- *Take into account the circumstances of this particular occurrence in their deliberations on the requirements for independent power supplies for on-board aircraft recordings.*

SAFETY RECOMMENDATION AJ/2004

4.2.7 Major Component Change Planning

Current regulations and industry standards do not mandate that the configuration of major components, such as an engine, be determined prior to the components being installed on the aircraft. In particular, the current method used for assigning a part number to an engine results in a part number that does not reflect which service bulletins have and which service bulletins have not been embodied. The overall number of involved service bulletins complicates the task of determining parity between similar major components. Because there is not a requirement for a major component-change planning process, nor a requirement to determine the precise configuration of the component during such a process, the responsibility for detecting differences in configuration is deferred to subsequent stages of the maintenance process.

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For this occurrence, the differences in configuration between the engine being removed and the engine being installed were not detected prior to the start of the engine change. As a result, determining part parity and ensuring integrity of the installation of the right engine rested solely with the level of the technician responsible for the engine change. Effectively, there was only one defence layer that could ensure the safety of the installation. The integrity of the engine changed hinged on using the Illustrated Parts Catalogue and the referenced service bulletins to verify the compatibility of each part being changed with associated/adjacent lines and components. The incompatibility of the hydraulic pump with the adjacent fuel pipe was eventually detected and lead to reference being made to the catalogue. However, difficulty in accessing the SB's, time pressures, prime focus on completing the installation, and other factors caused this one-level of defence to be ineffective in preventing an improper installation.

Therefore, it is recommended that Transport Canada, and Direction Générale de l'Aviation Civile of France, and the Civil Aviation Authority of the United Kingdom, as well as the EASA and civil aviation authorities of other states responsible for the manufacture of aircraft and major-components:

- *Review applicable airworthiness regulations and standards, as well as aircraft, engines and component maintenance manuals, to ensure that adequate defences exist in the pre-installation, maintenance planning process to detect major configuration differences and to establish the required support resources for technicians responsible for the work.*

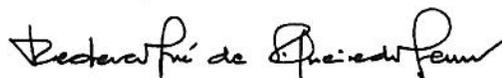
SAFETY RECOMMENDATION AK/2004

It is also recommended that Transport Canada, Direction Générale de l'Aviation Civile of France, and the Civil Aviation Authority of the United Kingdom, as well as the European Aviation Safety Authority and civil aviation authorities of other states, in conjunction with aircraft and major component manufacturers:

- *Review the adequacy of the current standards for identifying the configuration and modification status of major components to ensure that differences between major components of similar part numbers can be easily identified.*

SAFETY RECOMMENDATION AL/2004

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