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ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Aviation Supplementary Report – 200507077
Final

Engine failure/loss of control Toowoomba (ALA), Qld 27 November 2001

Beech Aircraft Corp C90, VH-LQH

Supplementary Report

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Supplementary Report

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Supplementary Report

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Abstract

On 25 June 2004, the Australian Transport Safety Bureau released its final investigation report into an accident which occurred on 27 November 2001 at Toowoomba aerodrome, Qld, involving a Beech Aircraft Corporation King Air C90 aircraft, registered VH-LQH, which experienced an engine failure shortly after takeoff. The aircraft was destroyed and all four occupants sustained fatal injuries. The report (200105618) is available on the ATSB website (www.atsb.gov.au).

In September 2005, a coronial inquiry into the accident was commenced. During that inquiry, new information was brought to the attention of the ATSB. As a result of this new information, the ATSB formally reopened the investigation on 11 November 2005 in accordance with Paragraph 5.13 of Annex 13 to the Chicago Convention through Section 17 of the *Transport Safety Investigation Act 2003*, to assess the matters raised and their significance to the original ATSB investigation findings.

In light of a further review of the evidence, the ATSB has reconsidered its original finding that the initiating event of the engine failure of VH-LQH was a blade release in the compressor turbine and proposes that an alternative possibility could have been that the initiating event occurred in the power turbine. Notwithstanding this possibility, in either scenario, the remainder of the findings and safety recommendations contained in the original ATSB report are still relevant.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations. Accordingly, the ATSB also conducts investigations and studies of the transport system to identify underlying factors and trends that have the potential to adversely affect safety.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and, where applicable, relevant international agreements. The object of a safety investigation is to determine the circumstances in order to prevent other similar events. The results of these determinations form the basis for safety action, including recommendations where necessary. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations.

It is not the object of an investigation to determine blame or liability. However, it should be recognised that an investigation report must include factual material of sufficient weight to support the analysis and findings. That material will at times contain information reflecting on the performance of individuals and organisations, and how their actions may have contributed to the outcomes of the matter under investigation. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. While the Bureau issues recommendations to regulatory authorities, industry, or other agencies in order to address safety issues, its preference is for organisations to make safety enhancements during the course of an investigation. The Bureau prefers to report positive safety action in its final reports rather than make formal recommendations. Recommendations may be issued in conjunction with ATSB reports or independently. A safety issue may lead to a number of similar recommendations, each issued to a different agency.

The ATSB does not have the resources to carry out a full cost-benefit analysis of each safety recommendation. The cost of a recommendation must be balanced against its benefits to safety, and transport safety involves the whole community. Such analysis is a matter for the body to which the recommendation is addressed (for example, the relevant regulatory authority in aviation, marine or rail in consultation with the industry).

EXECUTIVE SUMMARY

On 25 June 2004, the Australian Transport Safety Bureau (ATSB) released its final investigation report into an accident which occurred on 27 November 2001 at Toowoomba aerodrome, Qld, involving a Beech Aircraft Corporation King Air C90 aircraft, registered VH-LQH, which experienced an engine failure shortly after takeoff. The aircraft was destroyed and all four occupants sustained fatal injuries. The report (200105618) is available on the ATSB website (www.atsb.gov.au).

The factors which contributed to this accident were primarily maintenance-related. The ATSB issued six recommendations to the Civil Aviation Safety Authority (CASA) including reviewing:

- operator compliance with the requirements of mandatory turbine engine condition monitoring programs
- surveillance processes for confirming operator compliance with mandatory engine condition monitoring programs
- processes for identifying priority areas for consideration during airworthiness surveillance and approval activities
- processes to assess whether a maintenance organisation has adequate resources to conduct its required activities.
- the provision of formal advisory material to operators and pilots about managing engine failures and other emergencies during takeoff
- the assessment of synthetic training devices for the purpose of training pilots in making decisions regarding emergencies during critical stages of flight.

Since the accident, CASA has made changes to the requirements of AD/ENG/5 and to the processes for assessing the suitability of maintenance controllers.

In September 2005, a coronial inquiry into the accident was commenced. During that inquiry, new information was brought to the attention of the ATSB. As a result of this new information, the ATSB formally reopened the investigation on 11 November 2005 in accordance with Paragraph 5.13 of Annex 13 to the Chicago Convention through Section 17 of the *Transport Safety Investigation Act 2003,* to assess the matters raised and their significance to the original ATSB investigation findings.

As part of the reopened investigation, the ATSB's principal failure analyst was requested to review and comment on the evidence and analysis relating to the primary failure event for the left engine (refer to Attachment A of this supplementary report). The Transportation Safety Board of Canada (TSB) was also requested to review its original analysis (refer to Attachment B of this report).

In light of a further review of the evidence, the ATSB has reconsidered its original finding that the initiating event of the engine failure of VH-LQH was a blade release in the compressor turbine and proposes that an alternative possibility could have been that the initiating event occurred in the power turbine. Notwithstanding this possibility, in either scenario, the remainder of the findings and safety recommendations contained in the original ATSB report are still relevant.

BACKGROUND

At about 0836 Eastern Standard Time[1] on 27 November 2001, a Beech Aircraft Corporation King Air C90 aircraft, registered VH-LQH, took off from runway 29 at Toowoomba aerodrome, Qld, for an Instrument Flight Rules charter flight to Goondiwindi, Qld. On board were the pilot and three passengers.

Just prior to, or at about the time the aircraft became airborne, the left engine failed. A subsequent examination of the left engine found that it probably lost thrust-producing power almost immediately. Following the engine failure, the take-off manoeuvre continued and the aircraft became airborne prior to crashing. The aircraft was destroyed and all four occupants sustained fatal injuries. The accident was not considered to be survivable due to the impact forces and post-impact fire. The Australian Transport Safety Bureau (ATSB) commenced an investigation into the accident.

The engines (Pratt and Whitney Canada (P&WC) PT6A-20A) had been subject to an engine condition trend monitoring (ECTM) program in accordance with Airworthiness Directive AD/ENG/5. The pattern of ECTM data from the left engine indicated that a potentially safety-critical problem existed in that engine for some months prior to the accident. For a variety of reasons, that evidence was not detected and analysed, nor was appropriate remedial action initiated. Without timely intervention to address the developing engine problem, it was increasingly probable that the aircraft would have an in-flight emergency involving the left engine.

The PT6A engines from the accident aircraft underwent a preliminary disassembly examination at an approved engine overhaul facility under ATSB supervision. Because of other work pressures in the ATSB laboratories, the engines were subsequently shipped to the Engineering Branch Laboratory of the Transportation Safety Board (TSB) of Canada[2] for examination. The TSB stated that the pattern of evidence was consistent with a blade release event in the compressor turbine.

It was considered by the ATSB that a number of maintenance-related issues contributed to this accident. In addition to inadequate maintenance resources, the investigation noted that the defences within the operator's maintenance organisation were deficient in a number of other areas. The chief engineer had minimal preparation for his role as maintenance controller. He had also not completed ECTM training, and therefore the operator arranged to send the data to the engine manufacturer's field representative for analysis. However, the ECTM data were not being recorded or submitted for analysis as frequently as required by the engine manufacturer's requirements or AD/ENG/5. In addition, there were deficiencies in the operator's maintenance scheduling processes.

CASA was aware that the chief engineer had not completed ECTM training and that the operator had an arrangement to send ECTM data to the engine

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

2 Like the ATSB, the TSB of Canada conducts independent investigations for the purpose of enhancing transport safety.

manufacturer's field representative for analysis. However, CASA surveillance had not detected any problems with the operator's ECTM program prior to the accident.

Following the accident, CASA inspectors conducted a review of the engine condition monitoring programs of operators in their region. The review found that a number of the operators were not complying with relevant requirements.

The introduction of AD/ENG/5[3] allowed life extensions to be approved for PT6A engines in Australia under less restrictive circumstances compared with those required by the engine manufacturer.

By allowing a wider range of operators to extend time between overhauls (TBO), there was an onus on CASA to take measures to assure itself, during its surveillance activities, that operators were complying with the AD and conducting ECT appropriately. However, CASA's surveillance system was not sufficiently rigorous to ensure that the mitigators it had introduced within AD/ENG/5 for allowing TBO extensions were effective.

The investigation also noted that the CASA system for approving maintenance organisations and maintenance controllers did not appropriately consider the maintenance organisation's resource requirements.

The ATSB released its final investigation report on 25 June 2004 which included six recommendations to CASA. Since the accident, CASA has made changes to the requirements of AD/ENG/5 and to the processes for assessing the suitability of maintenance controllers.

In September 2005, a coronial inquiry into the accident was commenced. During that inquiry, new information was brought to the attention of the ATSB. As a result of this new information, the ATSB formally reopened the investigation on 11 November 2005 in accordance with Paragraph 5.13 of Annex 13 to the Chicago Convention through Section 17 of the *Transport Safety Investigation Act 2003*, to assess the matters raised and their significance to the original ATSB investigation findings.

The majority of the new information was contained in a statement from a former CASA engine specialist who was acting on behalf of CASA's insurer. The statement set out several areas of disagreement with the ATSB's original report. The central point of difference related to whether it would have been possible to detect the problem in the left engine prior to the accident flight by analysis of ECTM data, routine or overhaul inspection procedures.

As part of the reopened investigation, the ATSB's principal failure analyst was requested to review and comment on the evidence and analysis relating to the primary failure event for the left engine (refer to Attachment A of this report). The TSB was also requested to review its original analysis (refer to Attachment B of this report).

3 AD/ENG/5 *Turbine Engine Continuing Airworthiness Requirements* was first introduced in May 1985.

INFORMATION REVIEWED

Key findings of the original ATSB report

The following are extracts from the Findings section of the original ATSB report (200105618) which is available on the ATSB website (www.atsb.gov.au). They are considered relevant to the review of the new information provided by the former CASA engine specialist at the coronial inquiry into VH-LQH.

- Finding 3.1.2, 'The damage to the left engine was consistent with the fracture and release of one or more compressor turbine blades, which would have initiated the release of other compressor turbine blades and their subsequent impact with adjacent and downstream components, resulting in the loss of useful power'.
- Finding 3.1.3, 'There was no indication that the engine failure was due to manufacturing defects, metal fatigue, foreign object damage during flight, or the quality or quantity of fuel on board the aircraft'.
- Finding 3.1.4, 'Examination of the compressor turbine blades from the left engine indicated that they had been exposed to higher than normal operating temperatures in the period leading up to the accident'.
- Finding 3.1.7, 'The pattern of ECTM data from the left engine indicated that a potentially significant problem had also been developing in the cold section of the engine over the months preceding the accident'.
- Significant 3.2.1, 'The left engine failed during a critical phase of the takeoff. The failure was probably the result of a developing problem in the cold section of the engine, which was not detected or corrected due to several compounding deficiencies in the operator's maintenance system'.

Also attached to the original ATSB report as Appendix B, was the TSB specialist report, which included reference to Pratt and Whitney Canada (P&WC) report No. 01-119.

The Conclusion section of the TSB specialist report stated, in part:

- Conclusion 4.1, 'The damage pattern observed in the left engine is consistent with a blade release event from the compressor turbine' and 'the blade material had satisfied specifications requirements, and no manufacturing or processing defects were detected'.
- Conclusion 4.2, 'The microstructure of a representative blade indicated exposure to above normal operating temperature. This observation seems to be supported by the available data from the engine conditioning trend monitoring which tracked a 20 degree C rise in ITT [Inter Turbine Temperature] during the last few months prior to the incident'.

In summary, the ATSB considered that a developing problem in the left engine, evidenced particularly by elevated ITT (approximately 20 degrees Celsius) over a prolonged period, warranted further investigation in accordance with the requirements of the manufacturers maintenance manual table 2-7-1, ECTM Shift Fault Isolation table procedures, or Engine Performance Fault Isolation Chart Figure 2-7-3 in the P&WC PT6A -20 maintenance manual. Had maintenance personnel followed an escalating sequence of analysis and rectification activities, the chance of identifying the origin of the engine problem, and taking appropriate action to rectify the problem, would probably have been significantly improved.

Former CASA engine specialist statement to the inquest

The following sections of the CASA insurer's statement to the coronial inquiry are considered relevant to the review of the ATSB investigation. They have been set out in a manner that makes it easier to understand how particular comments relate to the ATSB report, rather than by successive paragraph or page number.

- Para 38, 'The ATSB requested the Canadian Transport Safety Board (TSB) to carry out a detailed examination of the accident engines. The TSB report details the left engine CT blades showed no evidence of fatigue or creep. However, high magnification examination indicated the blades had been subjected to abnormally high temperatures, high enough to cause a resolution of the blade microstructural gamma prime phase'.
- Para 33, '…at the strip examination, I concurred with the ATSB findings, that whilst both engines were operating at the time of impact, the left engine was not capable of producing useable power. The ATSB investigation determined that the failed CT blades had fractured in a manner consistent with an overload. The overload resulted from the fracture and release of one or more CT blades. Due to secondary damage to the remaining sections of CT blades, the site of the original fracture releases was not determined. The ATSB investigation did not disclose any evidence of combustion chamber or CT vane ring heat related distress'.
- Para 39, 'The Canadian TSB determined the left engine CT blades had been subjected to an abnormal operating temperature event that resulted in changes to the blade material microstructure. In the absence of any physical evidence disclosing that event, unless that over-temperature event was reported, for a PT6A-20A model engine, the event could not have been detected until blade failure occurred'.
- Para 37, 'However, neither a visual nor an overhaul level inspection would have detected changes in blade material microstructure'.
- Para 32, 'The P&WC CT blade overhaul level inspection for a PT6A-20A engine comprises a non destructive and dimensional examination of the blades. As such, the inspection would not detect changes in blade material microstructure'.
- Para 40, 'Given there was no evidence of CT blade creep or a change in blade profile, the engine over temperature event would not have been picked up by an ECTM program utilising manual recording data'.
- Para 41, 'Without physical evidence of blade creep or burning of the associated CT vane ring, the over temperature event could not have been detected at an overhaul level inspection or a HIS [Hot Section Inspection] or a boroscope inspection'.
- Para 47, 'In the material relied upon by the ATSB there is no evidence of CT blade distress in the ECTM data to 5 November 2001. The ECTM data detailed in the ATSB report discloses evidence of compressor deterioration, not CT blade

distress. Effective compliance with ECTM procedures mandated under AD/ENG/5 would not have prevented the 21 November 2001 CT blade failure(s)'.

In summary, the former CASA engine specialist did not consider that the quantum of the rise in engine temperature warranted an escalating sequence of analysis and rectification activities by maintenance personnel in accordance with AD/ENG/5, nor did the former CASA engine specialist believe that the origin of the engine problem could have been detected prior to the accident flight by ECTM data, routine or overhaul inspection procedures.

Supplementary review of evidence by the Transportation Safety Board of Canada

On the 9 December 2005, the ATSB made a formal request to the Transportation Safety Board of Canada (TSB) for further assistance with the specialist re-examination of the left engine. The TSB's supplementary report is at Attachment B. The TSB was asked to re-examine the left engine with particular emphasis on determining, if possible:

- if there was any evidence of fatigue crack growth from the trailing edge of power turbine blades for the left engine.
- the mechanism of fracture in the power turbine shaft housing at the transition to the number 3 bearing air seal (left engine).
- the mechanism of fracture of the power-turbine housing to propeller-reduction gearbox attachment studs (left engine).

In summary, the TSB supported the findings of their original examination, which stated that the evidence was consistent with a blade release event in the compressor turbine. However, in contrast to the conclusion in the original report, which stated that the change in microstructure of the compressor turbine blade was consistent with prolonged exposure to a 20 degree Celsius rise in Inter Turbine Temperature prior to the accident, the TSB supplementary report offered an alternative explanation, which suggested that it was possible for the temperature excursion which affected the blade microstructure to have occurred during the engine failure event:

> It is entirely possible that the temperature excursion to modify the gamma prime morphology occurred during the failure event. In fact, a loss of efficiency due to compressor blade loss frequently leads to an overheat condition.

The TSB also advised that:

> the gamma prime morphology over-temperature changes were confined to the area adjacent to the fracture surfaces.

Regarding the re-examination of the power turbine blades, the TSB advised that 'all available power turbine blades were re-examined with particular attention being paid to trailing edge cracks. No trailing edge cracks other than caused by impact damage with flying debris was found'. In addition, the TSB concluded that the trailing edge crack was the result of an overstress (collision with wreckage debris) situation rather than fatigue propagation under low alternating stress magnitude.

Further, '… the fractographic features do not reflect a fatigue mode of crack propagation'.

Finally, the TSB stated that the mechanism of failure of the power turbine housing was consistent with impact damage during the accident sequence and that the attachment studs were not fractured but displayed surfaces consistent with having been cut off by an abrasive saw during the disassembly of the engine. A Pratt and Whitney Canada (P&WC) specialist verbally advised the ATSB that he had not previously seen an event where the failure of a power turbine blade had caused out-of-balance rotation to the extent that it caused displacement of the inter-stage baffle and upstream collision with the compressor turbine section.

Review of evidence by ATSB principal failure analyst

At the time of the investigation into the engine failure of VH-LQH, it was impractical, due to other investigation priorities, for the ATSB's principal failure analyst to conduct a detailed examination of the aircraft's left engine. It was therefore considered appropriate to seek external assistance. As such, both engines of VH-LQH were subsequently shipped to the TSB for examination and analysis. However, prior to that decision, the principal failure analyst had conducted a preliminary examination of the physical evidence and formed a preliminary view that there was evidence of fatigue crack growth in the trailing edge of blades in the power turbine. When the investigation was reopened, the principal failure analyst reviewed the findings of his preliminary examination in light of the new information from CASA, and the original and supplementary reports from the TSB. The further work undertaken by the principal failure analyst supported his original view and he considered it possible that out-of-balance rotation could have resulted initially from a change in form or a loss of small fragments of the power turbine blade trailing edge as a result of the fatigue crack growth and could, in turn, explain the subsequent fracture of several blades from one section of the power turbine disc and the consequential upstream damage in the compressor turbine during the accident sequence.

The failure analyst advised that:

> a manufacturing flaw in a turbine blade was possible, though rare. If manufacturing flaws were present, crack growth and fracture would be expected to occur relatively early in the life of the component.

The principal failure analyst concurred with the original report findings, that the deviations of the parameters measured by the ECTM program were all increasing from an established baseline. However, and in accordance with the manufacturer's maintenance data, he advised that the upward trend could be an indicator not only of a problem in the compressor stage of the gas generator section, but equally, an indicator of a problem in the power turbine section of the left engine of VH-LQH[4].

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4 The P&WC maintenance manual p/n 3015442, Table 2-7-1 *ECTM Shift Fault Isolation* chart states that a probable cause of 'All parameter UP' could, inter alia, be: compressor contamination/dirt; a hot start; or that the power turbine (PT) stator vanes are burnt/flow area increased, or that there is PT blade tip oxidation/rub.

ATSB COMMENT

Based on the examination of the evidence at the time, the original ATSB investigation concluded that the pattern of ECTM data from the left engine indicated that a potentially significant problem had been developing in the cold section of the engine over the months preceding the accident. In reviewing the original investigation analysis and findings in light of the new information provided by the former CASA engine specialist, the supplementary examination by the TSB, and the ATSB's principal failure analyst, there is still a significant body of evidence which supports the central safety issue identified in the original ATSB investigation report. The ECTM data was both real and indicative of a trend significant enough to warrant a proactive response to identify and rectify a developing problem in the engine.

The former CASA engine specialist's statement suggests that the only plausible explanation for the change in microstructure of the compressor turbine blades was that it was the result of a previous hot start, or single 'hot event', that was not reported. However, the former CASA engine specialist advised that because there was no evidence of creep, fatigue or sulphidation, then neither the ECTM trend data nor any other prescribed maintenance inspection procedures would have identified an impending compressor turbine blade failure. The TSB's supplementary report offers an alternative explanation for the change in microstructure of the compressor turbine blades:

> It is entirely possible that the temperature excursion to modify the gamma prime morphology occurred during the failure event. In fact, a loss of efficiency due to compressor blade loss frequently leads to an overheat condition.

The TSB also reported that the gamma prime morphology over-temperature changes were confined to the area adjacent to the blade fractures. This would be further evidence that the over-temperature changes took place during the engine break-up sequence.

This alternative explanation appears to lend weight to the former CASA engine specialist's position that any flaws in compressor turbine blades were internal and could therefore not be detected prior to blade failure. However, the new TSB evidence would refute the engine specialist's assertion that a hot start was the most likely cause. In the event of a hot start over-temperature event of a magnitude that could cause the blades to progress to failure, it would be expected that the microstructural changes of creep, fatigue and sulphidation would be present in the majority of the recovered sections of the blades, and not only the area immediately adjacent to the fracture surface. The engine specialist agrees that there was no evidence of creep, fatigue or sulphidation to the blades.

The advice of the ATSB principal failure analyst was that it was rare for turbine blades to contain manufacturing flaws. If they were present, crack growth and fracture would be expected to occur relatively early in the life of the component. Given that the minimum age of the blades was determined to be 3,556 hours, it is considered unlikely that a manufacturing flaw contributed to the blade failure.

The former CASA engine specialist advised that there was no evidence of a change in blade profile of the compressor turbine blades. It is noted that the original specialist examination and report conducted by the TSB, which the ATSB investigation relied on, and the subsequent specialist examinations conducted by both the TSB and the ATSB, did not state that there was no change in compressor turbine blade profile. Given that the majority of the mid span and outer section of the compressor turbine blades were not recovered, the pre-impact profile of the blades cannot be known with any certainty. For this reason, it cannot be assumed that an overhaul inspection or dimensional examination of the blades would not have detected changes or damage in the compressor turbine blades.

The former CASA engine specialist's explanation for the upward trend in the ECTM data was that it was an indication of a general loss of efficiency in the compressor and not an indicator of a problem with the compressor turbine. While the upward trend in the ECTM data does support the possibility of a problem in the compressor stage of the gas generator, the same trend in parameters can also be an indicator of a problem in the power turbine (refer to footnote 4).

The ATSB maintains that the quantum of the rise in the ECTM data was significant enough to be an indicator of a problem more serious than a general loss of efficiency in the compressor and warranted an active investigation to determine the cause of that upward trend. In addition, if it is accepted that the problem was in fact in the power turbine with the power turbine blades deteriorating in the manner proposed by the ATSB principal failure analyst, then it is possible that a simple visual examination of the power turbine blades through the exhaust, could have identified the cause for the ECTM data trending up.

The ATSB principal failure analyst's report provided evidence in support of thermal fatigue cracking of power turbine blades as a possible explanation for the increasing ECTM trend data. The report included evidence to indicate that the thermal cracking could have led to one or more of the power turbine blades ultimately failing under load and the subsequent gross out-of-balance rotation and displacement of the inter-stage baffle, causing disruption to the (forward) compressor section. Opposing this view are the two reports from the TSB and the engine manufacturer (P&WC). In their supplementary report, the TSB and P&WC reiterate their original finding that compressor turbine blade failure was the lead event in the power loss of the left engine but no explanation for the blade failure is offered, principally because extensive mechanical damage precluded isolation of the initiating blade.

While it is not reasonable to discount the significance of any of the evidence and analysis contained in either the TSB or the ATSB specialist reports as to the initiating event that led to the engine failure of VH-LQH, it is important to note that neither report presents evidence which is contrary to the central safety issue of the original ATSB investigation report. The management of and response to the increasing ECTM trend data remains the central safety issue of that investigation.

If the staged maintenance actions required in response to the upward trending ECTM data were accomplished in accordance with the engine manufacturer's guidance, which has as a primary requirement to determine and correct the cause for over temperature, it is probable that one of the increasing stages of examination specified would have identified the problem. Irrespective of whether the upward trend in ECTM data was caused by a problem in the compressor or the power turbine section of the engine, it is not considered appropriate to allow an engine to continue in service without taking all reasonable steps to determine and rectify the reason/s for the elevated trend.

In light of a further review of the evidence, the ATSB has reconsidered its original finding that the initiating event of the engine failure of VH-LQH was a blade release in the compressor turbine and proposes that an alternative possibility could have been that the initiating event occurred in the power turbine. Notwithstanding this possibility, in either scenario, the remainder of the findings and safety recommendations contained in the original ATSB report are still relevant.

ATTACHMENTS

Attachment A: ATSB additional analysis of left engine failure