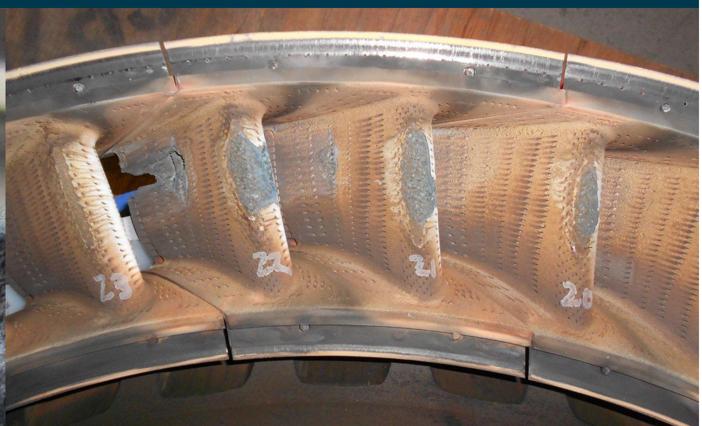
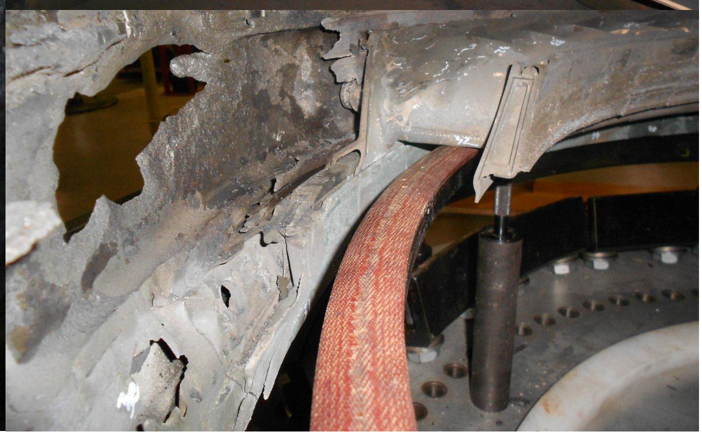
Australian Government

Australian Transport Safety Bureau

Engine failure involving Airbus A380, A6-EDA

near Sydney Airport, NSW, | 11 November 2012





Investigation

ATSB Transport Safety Report

Aviation Occurrence Investigation

AO-2012-150

Final – 9 September 2013

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Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

Addendum

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Safety summary

What happened

On 11 November 2012, an Emirates A380 aircraft, registered A6-EDA, departed Sydney Airport for Dubai, United Arab Emirates. While climbing through an altitude of approximately 9,000 ft, the crew reported hearing a loud bang, accompanied by an engine No 3 exhaust gas temperature over-limit warning. Shortly thereafter, the engine went through an uncommanded shut down. The crew jettisoned excess fuel and returned the aircraft to Sydney for a safe landing and disembarkation of the passengers and crew.

HPT stage-2 nozzle distress

Source: UK AAIB

What the ATSB found

The investigation found that the increase in the exhaust gas temperature and subsequent engine shut down was a result of significant internal damage that had initiated within the high pressure turbine (HPT) module. The damage had resulted from the effects of HPT stage-2 nozzle distress, likely caused by exposure to hotter than expected operating temperatures. The nozzle distress led to eventual failure and separation into the gas flowpath. Over the preceding weeks there were two other engines within the operator's fleet that had experienced a similar problem, and a number of steps had been taken by the manufacturer to address the issue, including the increased monitoring of distress development. During the previous flight, the engine health and trend monitoring program had identified a performance trend shift with this particular engine, and it was due to be inspected upon return to the main base in Dubai.

What's been done as a result

The engine manufacturer, Engine Alliance, had issued a service bulletin in June 2010 for the replacement of affected HPT stage-2 nozzle segments with new, more durable components during the next workshop visit when the HPT stage-2 was removed from the engine. Following this occurrence, another service bulletin was released on 6 December 2012, requiring the direct inspection of the nozzle segments that had not yet been replaced. The US Federal Aviation Administration also released an Airworthiness Directive which required inspection of the nozzle segments and their removal from service if distress was identified.

As the nozzle degradation mechanism was an emerging issue for the engine manufacturer at the time of the occurrence, the information and experiences associated with this occurrence have been used to refine and improve the trend monitoring program. Under the new limits set, this engine would have been inspected two flights prior to the occurrence flight. At the time this report was released, the manufacturer was continuing work to better understand the initial onset of nozzle distress and potential for further design improvements.

Safety message

While the distress to the HPT was severe enough in this case to result in an in-flight engine shutdown, the associated risks to the safety of continued flight were relatively low, given the failure had been contained and the operator's procedures were effective in managing the engine shut down. This occurrence also pointed to the value of real-time engine condition monitoring, since advanced warning of engine degradation and efficiency loss allows inspection and corrective action before damage progresses to a level where it can cause an in-flight shut down.

Contents

The occurrence

On 11 November 2012, at approximately 2200 EDT[1] an Emirates Airbus A380 aircraft, registered A6-EDA, departed Sydney Airport, New South Wales (NSW) for Dubai, United Arab Emirates. While climbing through an altitude of approximately 9,000 ft, the flight crew reported hearing a loud bang, which was accompanied by an engine exhaust gas temperature over-limit warning. This was followed by an uncommanded shutdown of the No 3 engine (right inboard). The flight crew jettisoned excess fuel and returned the aircraft to Sydney (Figure 1) for a safe landing and disembarkation of the passengers and crew.

Figure 1: Flight path of A6-EDA following departure from Sydney Airport, NSW

Source: Google Earth/ATSB

A witness to the event reported hearing a distant bang at approximately 2200 on the night of the occurrence, followed by impact noises on the tile roof of their property in Riverstone NSW. Pieces of suspected engine debris (Figure 2) were later collected by the NSW police service.

Figure 2: Pieces of engine debris recovered from Riverstone, NSW

Source: NSW Police

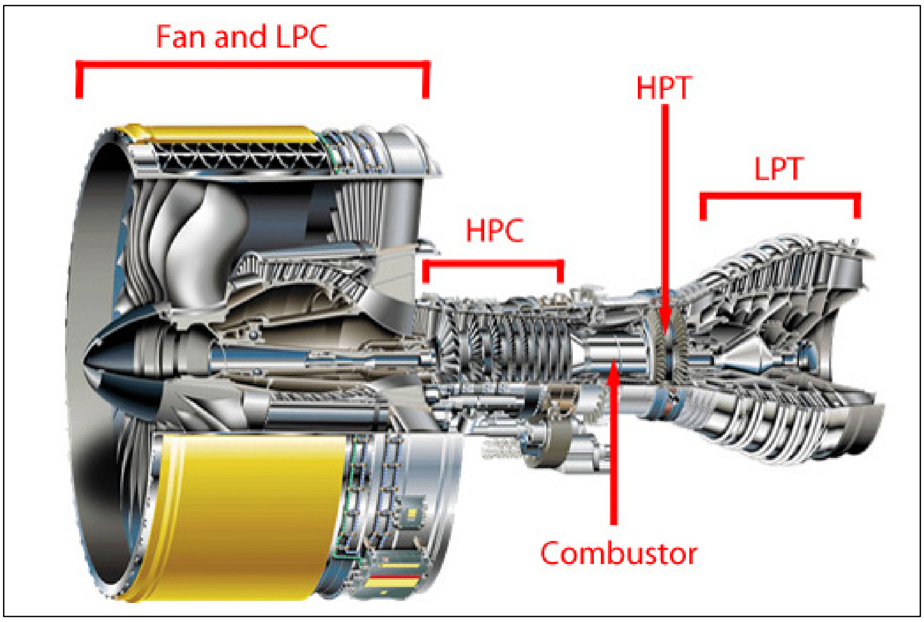
[1] Australian Eastern Daylight Savings Time (EDT) was Coordinated Universal Time (UTC) + 11 hours.

Context

Engine description

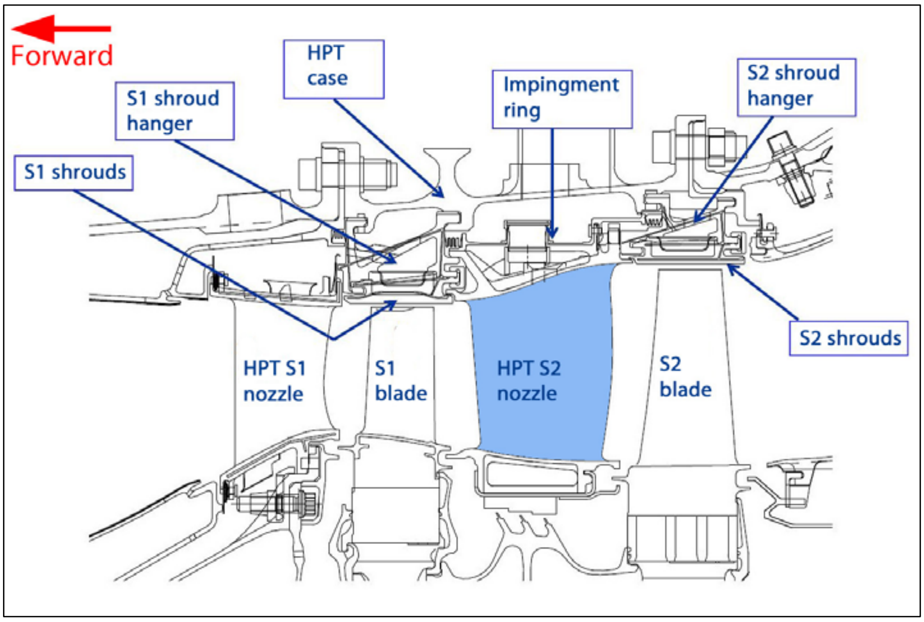
The aircraft's propulsion was generated by four Engine Alliance[2] GP7200 high-bypass, two-rotor, axial flow turbofan engines (Figure 3). The engine comprises a single stage fan, a five stage low pressure compressor (LPC), a nine stage high pressure compressor (HPC), a two stage high pressure turbine (HPT, Figure 4) which drives the HPC, and a six stage low pressure turbine (LPT) which drives the fan and LPC.

Figure 3: Overview of GP7200 engine



Source: Engine Alliance

Figure 4: High pressure turbine (HPT) component identification



Source: Engine Alliance

2 Engine Alliance is a joint venture between General Electric and Pratt and Whitney

Engine examination

Examination of the No 3 engine following landing found metal debris in the tailpipe, visible damage to the LPT and three small impact marks approximately 300 mm forward of the wing trailing-edge flap (immediately behind the engine and in line with the exhaust path). There was no evidence of impact damage to the engine nacelle.

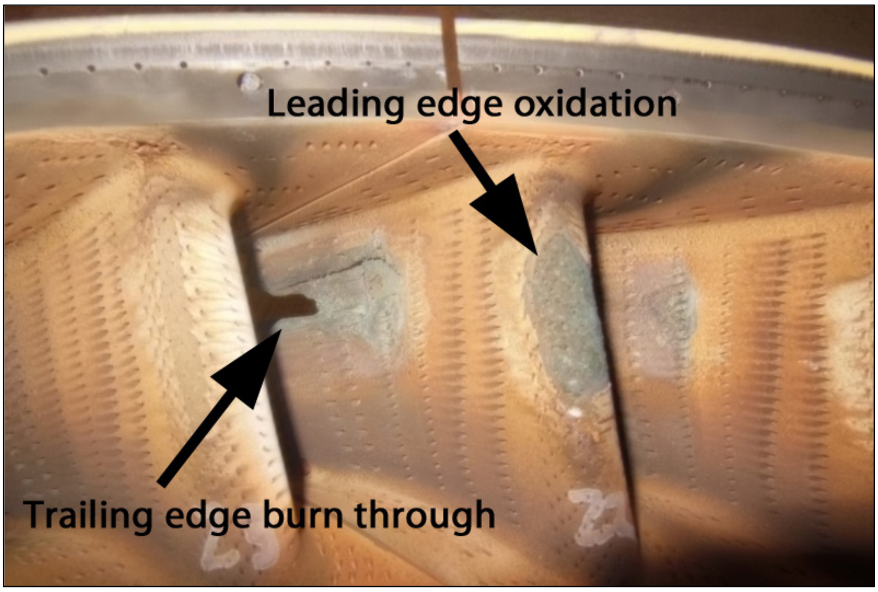
Initial borescope inspection of the engine internals showed high pressure turbine (HPT) module distress, including dislodgment of some HPT stage-2 nozzle segments and significant downstream mechanical damage.

The engine was removed from the aircraft and sent to the engine manufacturer's facility in Wales, UK for disassembly and further examination. The engine was inducted into the workshop in January 2013, and work was subsequently undertaken under the supervision of investigators from the UK Aviation Accident Investigation Branch (AAIB), acting as accredited representatives to the ATSB investigation.

Key observations from the disassembly and examination of the engine included:

- The fan, LPC and HPC exhibited no significant damage.
- The combustor and fuel nozzles were in good condition with no notable burning or streaking on inner or outer liners.
- The majority of damage sustained by the engine was within the HPT module and downstream.
- Damage to the HPT componentry was most severe in the 6:00 to 9:00 o'clock position (aft looking forward). From the HPT stage-1 shrouds rearward, the nozzles, shrouds and shroud hangers were missing in that quadrant.
- All 40 of the HPT stage-1 nozzles showed varying levels of leading edge distress, including missing thermal barrier coating, oxidation of the base metal and trailing edge burn through (Figure 5). Three nozzles showed distress in the fourth row of cooling holes and two trailing edge inserts showed a white dust accumulation.

Figure 5: HPT stage-1 nozzles (forward looking aft)



Source: Engine Alliance

The HPT stage-1 shroud hangers showed varying levels of obstruction of the baffles[3], consistent with dust accumulation (Figure 6).

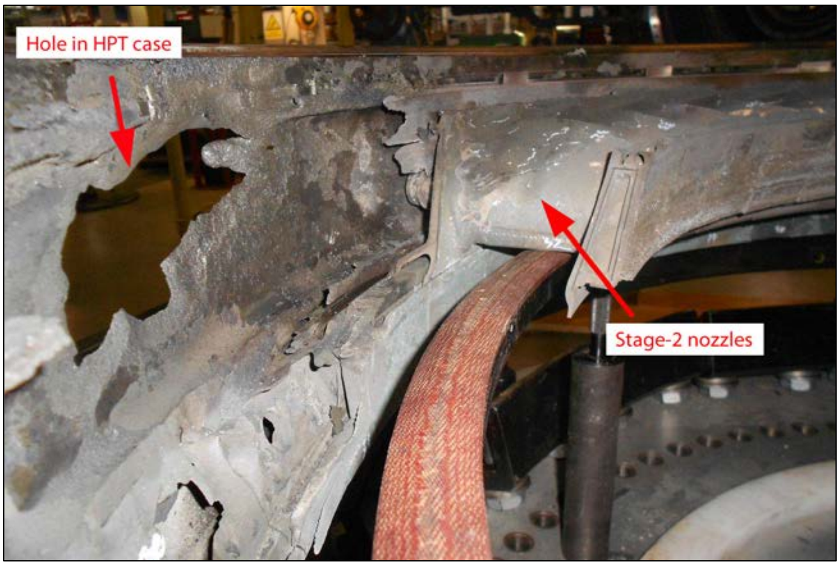
Figure 6: Dust accumulation in HPT stage-1 shroud hangers

Source: Engine Alliance

The HPT stage-1 and 2 blades were all present in the disc, however the stage-1 blades exhibited tip distress and loss of the thermal barrier coating on the pressure (concave) side of the airfoil.

An irregular hole of approximately 4” by 1.5” (100 mm x 37 mm) was located at approximately 9:00 o’clock (aft looking forward) in the HPT case in the plane of the stage-2 nozzles (Figure 7). The hole was not the result of high energy penetration, but was likely the result of erosive oxidation of the case walls as a result of hot flowpath gas getting around the damaged stage-2 nozzles and exposing the inner case surface to greatly elevated temperatures.

Figure 7: Hole in HPT case and missing stage-2 nozzles



Source: Engine Alliance

The external HPT active clearance control manifold[4] was heat damaged at the 9:00 o’clock location due to the hole in the HPT case.

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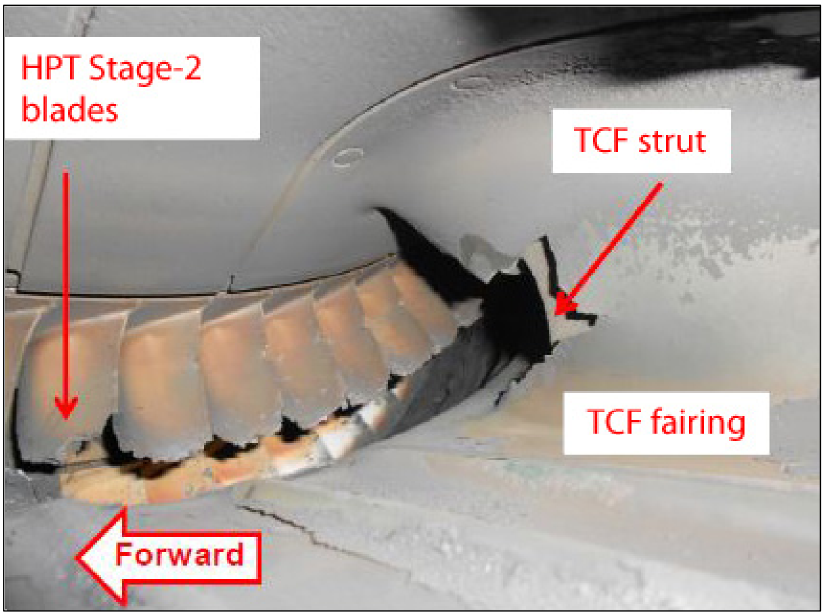
3 Baffles on the shroud hanger are used to control the airflow onto the shroud.

The turbine centre frame (TCF) exhibited extensive impact damage to the panels, fairings and struts. The damage was a result of impinging material liberated from the upstream disruption (Figure 8).

Figure 8: Damage to turbine centre frame (TCF) and HPT stage-2 nozzles



Source: Engine Alliance

The LPT forward stage nozzles exhibited significant damage and loss of material. While the LPT stage-1 blades had remained in position within the disc slots, many forward stage airfoils were missing or severely damaged.

Engine history

At the time of the occurrence, the No 3 engine (serial number P550121) had operated for a total of 15,318 hours (TSN) and 1,876 flight cycles (CSN) since new. Of that, 6,748 hours and 793 flight cycles had accumulated since the last engine workshop visit. At the time of the occurrence, there were no open or outstanding items on the engine's maintenance log.

As a result of engine trend monitoring during the previous flight, an *Urgent Remote Diagnostic Notice*[5] for HPC efficiency deterioration had been issued to the operator by the engine manufacturer. In accordance with the diagnostic notice from the manufacturer, the issue was due to be investigated on the aircraft's return to the main base in Dubai.

HPT stage-2 nozzle distress

On June 4, 2010 the engine manufacturer released service bulletin (SB) EAGP7 72-127, *Engine – HPT stage 2 nozzle assembly – improved durability of HPT stage 2 nozzle segments*. The bulletin advised of the availability of new HPT stage-2 nozzle segments and HPT spline seals aimed at improving turbine nozzle durability. The bulletin noted that thermal barrier coating loss (spallation), parent metal oxidation and cracking had been observed on the HPT stage-2 nozzles during examination of a factory test engine. The solution was to reduce metal temperatures by modifying the nozzle cooling and spline seal configuration, with feedback from workshop inspections

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4 The active clearance control system is a design feature for more actively controlling the HPT blade tip clearance for more efficient engine operation.

5 An *Urgent Remote Diagnostic Notice* is a specific customer notification report sent by the engine manufacturer that alerts operators when certain engine parameter criteria are exceeded, and provides inspection recommendations for the associated condition.

reporting improved durability of the new nozzles. The bulletin recommended that the nozzles and spline seals be replaced when the HPT stage-2 was next removed from the engine. At the time of the occurrence, the No 3 engine of A6-EDA had not yet had the SB embodied, and contained the pre-service bulletin nozzles and seals.

Other occurrences

An *all-operators* communication issued by the manufacturer on 15 November 2012 advised that in the preceding four weeks, four other engines within the world-wide fleet had been identified with HPT stage-2 nozzle distress. Four of the five engines (including the occurrence engine) had HPT stage-2 nozzle parts specified in SB EAGP7 72-127, however, one engine had the new part number nozzles and spline seals introduced by the service bulletin. The details of the events are given below.

Pre-SB EAGP72-127 engines (all showed similar signs of distress)

- Engine serial number P550114, 14 October 2012 – Exhaust gas temperature (EGT) exceedence during flight and subsequent examination found two HPT stage-2 nozzles with significant distress. Engine TSN 14774, CSN 1857.
- Engine serial number P550115, 21 October 2012 – Unscheduled borescope inspection as a result of EGT trend monitoring and a customer report; leading edge nozzle airfoil cracking or burn through near outer band found during inspection. Engine TSN 15517, CSN 1938.
- Engine serial number P550133, 12 November 2012 – Unscheduled borescope inspection as a result of EGT trend monitoring revealed HPT Stage-2 nozzle distress. Engine TSN 10629, CSN 1837.

Post-SB EAGP7-72-127 engine

- Engine P550155, 14 November 2012 –Unscheduled borescope inspection in accordance with EGT trend monitoring revealed HPT stage-2 nozzle distress. EngineTSN 11735, CSN 1996.

  As this engine had the new components installed, examination and further testing of the engine was carried out at the manufacturer’s facility in March and April 2013.

Service documentation changes following the occurrence

As a result of the A6-EDA occurrence and subsequent inspection findings, on 6 December 2012 the engine manufacturer issued SB EAGP7-72-190, *Engine – high pressure turbine – inspection of pre-service bulletin EAGP7-72-127 HPT stage 2 nozzle segments*. The bulletin provided instructions for an on-wing borescope inspection of engines with the pre-SB EAGP7-72-127 nozzles for leading edge airfoil/outer platform distress. Initially, for engines above 1,500 CSN, inspection was recommended within the next 100 flight cycles. For engines above 1,700 CSN, inspection was recommended within 50 cycles.

The US Federal Aviation Administration (FAA) released airworthiness directive AD FAA-02-06 in January 2013, which required initial and repetitive borescope inspections and the immediate removal of the engine from service if one or more burn holes were detected in pre-SB EAGP7-72-127 HPT stage-2 nozzles. The AD required inspections before the engine reached 1,500 CSN if the nozzles had fewer than 1,450 CSN; or within the next 50 cycles if the nozzles had 1,450 or more CSN. The AD also called for a repeat inspection at 100 cycle intervals, and required replacement of the early configuration nozzles at the next workshop visit.

An alternate method of compliance with the AD was approved on 13 March 2013, allowing operators to extend the re-inspection interval from 100 to 150 cycles, and defining the next workshop visit as one where ‘disassembly of the engine was sufficient for removal of the HPT stage-2 nozzle assembly for access or for an unserviceable condition’. A revision of SB EAGP7-72-190 was released to reflect the new inspection requirements.

As a result of the 14 November 2012 event, and although the new nozzles had shown improved durability during factory testing, the engine manufacturer released SB EAGP7-72-262, *Engine – high pressure turbine – inspection of post-service bulletin EAGP7-72-127 HPT stage 2 nozzle segments* on 30 January 2013. The required inspections and intervals were similar to the pre-SB EAGP7-72-127 nozzles.

As of 20 November 2012, all engines in the operator's fleet of A380 aircraft had the new nozzles installed as per SB EAGP7-72-127.

Safety analysis

The 11 November 2012 engine failure and in-flight shut down event involving Emirates Airbus A380 registration A6-EDA, was the result of the break up and dislodgement of some stage-2 high-pressure turbine (HPT) nozzles, producing substantial downstream damage and allowing a breach to develop within the turbine casing walls. The nozzle failure stemmed from the effects of cumulative oxidation and distress across the airfoil surfaces.

During the previous flight, the engine manufacturer's condition monitoring program had noted some adverse trends in the engine's operating parameters, prompting the issue of an *Urgent Remote Diagnostic Notice* that alerted the operator to the potential deterioration of the aircraft's No 3 engine high pressure compressor (HPC) efficiency. As a result, an inspection of the engine was scheduled upon the aircraft's return to the main base in Dubai. At the time of the failure event, the engine's exhaust gas temperature (EGT) and HPC trend monitoring criteria were not yet at a level that would have required an immediate inspection of the engine.

Based on the review of the hardware removed from the failed engine, together with the analysis of dust residue, engine trend data and a recently tested field engine (serial number P550155), the engine manufacturer proposed that hotter than expected metal surface temperatures at the HPT stage-2 nozzle forward attachments had led to the accelerated hardware distress. Factors such as the engine combustion gas temperature profile, a degraded nozzle cooling capability (resulting from the accumulation of environmental dust deposits) and the engine operating regime have been identified as contributing to the higher metal surface temperatures.

The engine manufacturer reported that HPT stage-2 nozzle distress has only been observed on engines that have accumulated more than 1,800 operational cycles. The distress appeared to be a progressive degradation mechanism, driven by accumulated time exposed to high temperatures.

Ongoing issue

While the new post-SB EAGP7-72-127 nozzles and seals have shown improved durability, the November 2012 discovery of nozzle distress within an engine fitted with the newer nozzle design has suggested that the issues surrounding the development of nozzle distress within the HPT stage-2 turbine area may not have been fully addressed. At the time of publishing this report, the engine manufacturer was continuing work to better understand the conditions that can lead to HPT distress and to further improve the durability of the HPT components.

Containment

While the engine breakdown mechanism had produced a breach in the turbine casing, that damage was entirely consistent with thermal and oxidation effects resulting from the passage of hot gases past the damaged HPT stage-2 nozzles and shroud. Other than the release of some metallic material from the rear of the engine, there was no evidence that high-energy debris had escaped from the engine during the failure and, as such, the event was considered as contained. The hazard associated with the release of a small number of lightweight items was considered to be minor, as the likelihood is low and the consequence generally minimal.

A contained engine failure is one in which components within the engine might separate but either remain in the engine's cases or exit the engine with comparatively low energy through the tail pipe. Although associated with a loss of propulsive power, contained failures in most instances do not otherwise pose a risk to the aircraft structure, systems or occupants.

Findings

From the evidence available, the following findings are made with respect to the in-flight engine shut down occurrence involving Emirates Airbus A380, A6-EDA, and should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing factors

- **The design cooling characteristics of the Engine Alliance GP7200 high pressure turbine (HPT) stage-2 nozzle components led to higher than expected metal surface temperatures during operation, rendering the nozzles susceptible to distress, premature degradation and failure. [Safety issue]**
- Damage from the liberation of HPT stage-2 nozzle components led to the subsequent uncommanded shutdown of the No 3 engine.

Other factors that increased risk

- **The threshold limits for the engine trend monitoring program were not set at a level that provided sufficient opportunity for inspection of the engine before failure could occur from the effects of HPT stage-2 nozzle degradation. [Safety issue]**

Other findings

- The turbine nozzle distress was a progressive degradation mechanism, driven by accumulated time exposed to high temperatures, and exacerbated by environmental dust accumulation and sustained high power settings.
- While the engine turbine case was damaged as a result of exposure to high temperatures, the engine failure was contained and there was no release of high energy debris.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

High pressure turbine stage-2 nozzle distress

Number:	AO-2012-150-SI-01
Issue owner:	Engine Alliance
Type of operation:	Air transport
Who it affects:	All operators of A380 aircraft with Engine Alliance GP7200 engines fitted

Safety issue:

The design cooling characteristics of the Engine Alliance GP7200 high pressure turbine (HPT) stage-2 nozzle components led to higher than expected metal surface temperatures during operation, rendering the nozzles susceptible to distress, premature degradation and failure.

Proactive safety action taken by: Engine Alliance

Prior to the occurrence, Engine Alliance had already made design changes to the HPT stage-2 nozzle design to improve durability. On 6 December 2012, the engine manufacturer released a service bulletin (SB EAGP7-27-190) which provided on-wing inspection instructions for susceptible HPT stage-2 nozzles. When similar nozzle distress was discovered on an engine with the new configuration nozzles installed, the engine manufacturer released another service bulletin (SB EAGP7-72-262) with similar inspections to those for the older nozzles. The engine manufacturer is continuing to study the cooling characteristics of the HPT stage-1 nozzles, stage-1 shrouds and the stage-2 nozzles for potential further design improvements.

Action number: AO-2012-150-NSA-011

ATSB comment in response:

The ATSB is satisfied that the action taken by Engine Alliance, in combination with others, adequately addresses the safety issue.

Proactive safety action taken by: Federal Aviation Administration (FAA)

An airworthiness directive (AD) was released in January 2013, AD FAA-02-06, which required initial and repetitive borescope inspections and removal from service before further flight if one or more burn holes were detected in pre-SB EAGP7-72-127 HPT stage-2 nozzles.

Action number: AO-2012-150-NSA-013

ATSB comment in response:

The ATSB is satisfied that the action taken by the FAA in combination with others adequately addresses the safety issue.

Proactive safety action taken by: Emirates

As of 20 November 2012, all engines in the operator's fleet of A380 aircraft had the new nozzles installed as per SB EAGP7-72-127.

Action number: AO-2012-150-NSA-010

ATSB comment in response:

The ATSB is satisfied that the action taken by Emirates in combination with others adequately addresses the safety issue.

Current status:

Issue status: Adequately addressed

Justification: The new HPT stage-2 nozzles have been installed across the majority of the high-time engines within the worldwide fleet. Additionally, there are repetitive inspections in place for both the new and old nozzle configurations and condition monitoring improvements have been put in place. The ATSB is satisfied that the action taken will reduce the prevalence of HPT stage-2 nozzle distress and will identify nozzle distress before it progresses to a stage that would impact flight operations.

Engine trend monitoring limits

Number:	AO-2012-150-SI-02
Issue owner:	Engine Alliance
Type of operation:	Air transport
Who it affects:	All operators of A380 aircraft with Engine Alliance GP7200 engines fitted

Safety issue

The threshold limits for the engine trend monitoring program were not set at a level that provided sufficient opportunity for inspection of the engine before failure could occur from the effects of HPT stage-2 nozzle degradation.

Proactive safety action taken by: Engine Alliance

As a result of the occurrence, the engine manufacturer enhanced the trend monitoring system to receive alerts earlier. Under the new process, the change in exhaust gas temperature on engine serial number P550121 would have issued an 'Urgent – Prior to next flight' notice two flights prior to the occurrence flight.

Action number: AO-2012-150-NSA-012

ATSB comment in response:

The ATSB is satisfied that the action taken by Engine Alliance adequately addresses the safety issue.

Current status:

Issue status: Adequately addressed

Justification: The introduction of the new HPT stage-2 nozzles and repetitive inspections in place for both the new and old nozzle configurations will reduce the prevalence of HPT stage-2 nozzle distress and will identify nozzle distress before it progresses to a stage that would impact flight. The enhanced trend monitoring system that has been put in place provides additional assurance that an impending nozzle failure is identified in time for preventative maintenance action.

General details

Occurrence details

Date and time:	11 November 2012 – 2210 EST	
Occurrence category:	Incident	
Primary occurrence type:	Engine failure	
Location:	Near Sydney Airport (NSW)	
	Latitude: 33° 40.30' S	Longitude: 150° 52.55' E

Aircraft details

Manufacturer and model:	Airbus A380-861	
Registration:	A6-EDA	
Operator:	Emirates Airlines	
Aircraft serial number:	0011	
Engine Type	Engine Alliance GP7270	
Engine serial number	P550121	
Type of operation:	Air transport high capacity	
Persons on board:	Crew – 28	Passengers – 380
Injuries:	Crew – nil	Passengers – nil
Damage:	Minor	

Sources and submissions

Sources of information

The sources of information during the investigation included:

Engine Alliance

Emirates Airlines

The UK Aviation Accident Investigation Branch

The New South Wales Police Service

Federal Aviation Administration

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the aircraft operator, the engine manufacturer, the Civil Aviation Safety Authority, the UAE General Civil Aviation Authority, the UK Air Accident Investigation Branch, the National Transportation Safety Board and the aircraft manufacturer.

Submissions were received from the aircraft operator, the engine manufacturer, the Civil Aviation Safety Authority and the UAE General Civil Aviation Authority. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

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.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. 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.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
Engine failure involving Airbus A380, A6-EDA
near Sydney Airport, NSW, 11 November 2012

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