



Australian Government

Australian Transport Safety Bureau



ATSB TRANSPORT SAFETY REPORT
Aviation External Investigation AE-2009-046
Final

Aircraft instrument and fuel system
debris examination
Bell 206 L4, P2-HBC,
collision with terrain in the vicinity
of Lake Murray PNG,
25 September 2008



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examination
Bell 206L4, P2-HBC
Collision with Terrain in the
vicinity of Lake Murray PNG
25 September 2008**

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Abstract

On 25 September 2008, the pilot of a Bell 206L4 helicopter, registered P2-HBC, was conducting sling loading operations in the vicinity of Lake Murray, Papua New Guinea. While conducting a vertical lift, a witness reported hearing a 'different noise' from the helicopter's engine, before observing the pilot jettison the load. The witness then observed the helicopter oscillating from side to side, yawing to the left and then descending through the tree canopy to impact the ground. The pilot was fatally injured and the helicopter seriously damaged.

This accident is being investigated by the Papua New Guinea Accident Investigation Commission (AIC) in accordance with its obligations under Annex 13 to the Convention on International Civil Aviation. The AIC requested the Australian Transport Safety Bureau's (ATSB's) assistance with their investigation by providing forensic engineering examination of a small selection of instruments and some fuel system detritus recovered from the accident helicopter.

The ATSB subsequently received and examined a fuel quantity gauge, turbine outlet temperature (TOT) gauge and an annunciator panel from the helicopter's instrument cluster. Various marks and observations evident on the components were documented and analysed with respect to the possible relevance of those markings to the accident event. In addition, a small sample of dried material from the internal surfaces of the fuel filter check valve that was provided by the AIC was examined and found to be characteristic of the biopolymer films produced by microbial growth.

FACTUAL INFORMATION

Introduction

On 25 September 2008, the pilot of a Bell 206L4 helicopter, registered P2-HBC, was conducting sling loading operations in the vicinity of Lake Murray, Papua New Guinea (PNG). While conducting a vertical lift, a witness reported hearing a 'different noise' from the helicopter engine, before observing the pilot jettison the load. The witness then observed the helicopter oscillating from side to side, yawing to the left and then descending through the tree canopy to impact the ground. The pilot was fatally injured and the helicopter seriously damaged.

Service Request

This accident is being investigated by the Papua New Guinea Accident Investigation Commission (AIC) in accordance with its obligations under Annex 13 to the Convention on International Civil Aviation. The AIC requested the Australian Transport Safety Bureau's (ATSB's) assistance with their investigation by providing forensic engineering examination of a small selection of instruments and some fuel system detritus recovered from the accident helicopter.

In accordance with paragraph 5.23 of Annex 13, the ATSB appointed an Accredited Representative and initiated an investigation under the *Transport Safety Investigation Act 2003* to protect any work undertaken to assist the AIC, and any information supplied to the ATSB by the AIC.

Items received

The following components and materials were received from the PNG AIC investigator-in-charge:

- fuel quantity gauge, part No. 83-104-1 / serial No.9818-159 (Figure 1)
- turbine outlet temperature (TOT) gauge, part No.SEL-019DT / serial No.489A (Figure 2)
- warning annunciation panel: Serial No. 9818-157 (Figure 3)
- sample of detritus removed from the internal surfaces of the helicopter primary fuel filter check-valve assembly (Figure 4).

Figure 1: Fuel quantity gauge



Figure 2: Turbine outlet temperature gauge (TOT)



Figure 3: Warning annunciator panel

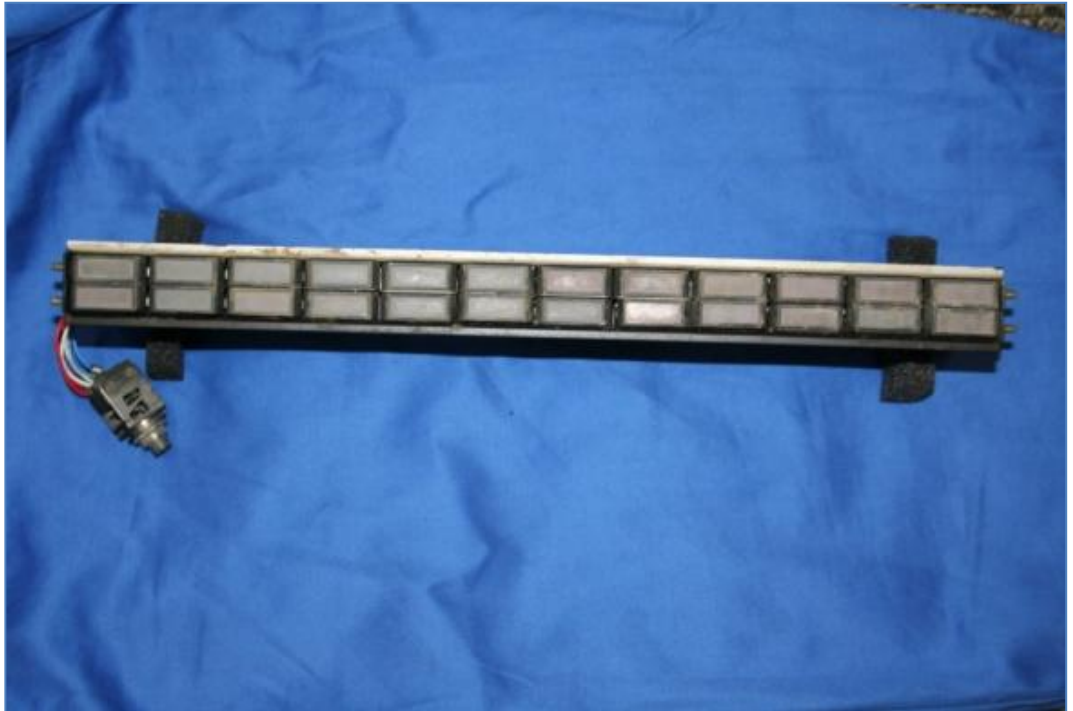
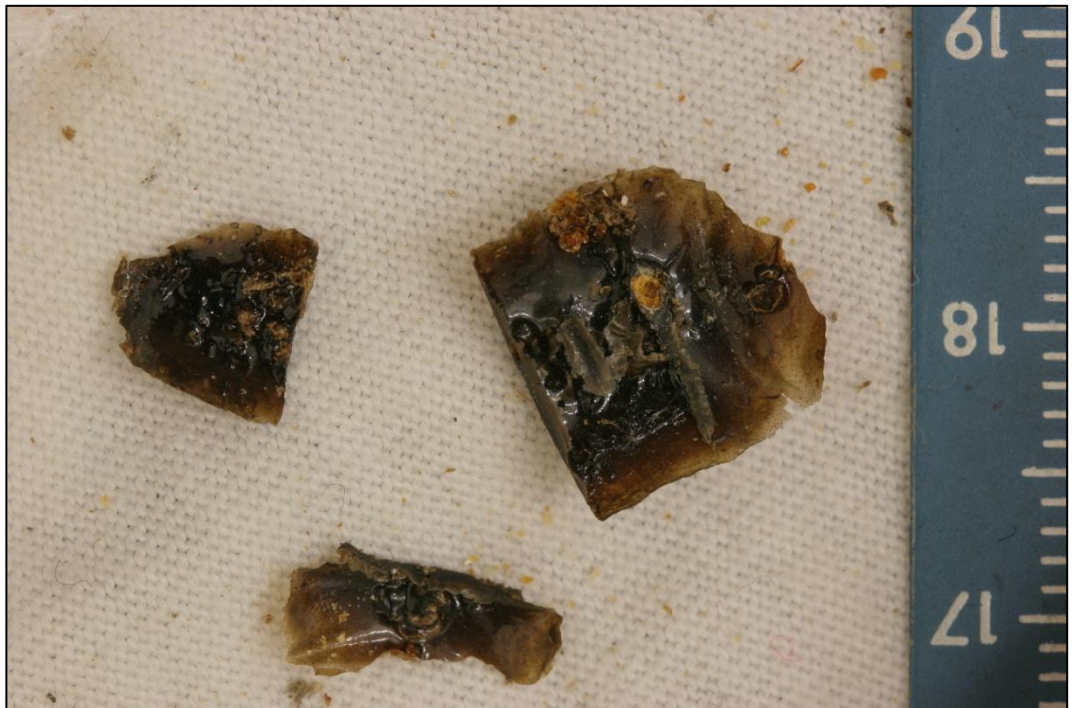


Figure 4: Sample of detritus from the helicopter fuel system



Examination

Fuel quantity gauge

The face-plate of the fuel quantity gauge was examined (both unaided and with a binocular microscope) for scratch marks, paint deposits or impressions made on the face of the instrument, consistent with the pointer of the gauge coming into contact during the accident impact sequence. Such marks, if created at impact, may be used to suggest the fuel gauge reading prior to the accident.

Various marks were found on the face of the fuel quantity gauge. Small paint deposits from the underside of the pointer were evident on the instrument face from an area of contact which correlated with a gauge reading of approximately 300 to 330 lb (Figure 5).

Figure 5: Paint marks on instrument face



Examination of the gauge pointer identified a small paint protrusion on the underside surface, towards the pointer base (Figures 6 and 7). That protrusion was found to align with the location of the paint marks on the gauge face (Figure 6).

Figure 6: Comparison of the position of the dislodged paint on the protrusion on the underside of the pointer with paint marks found on the face of the instrument

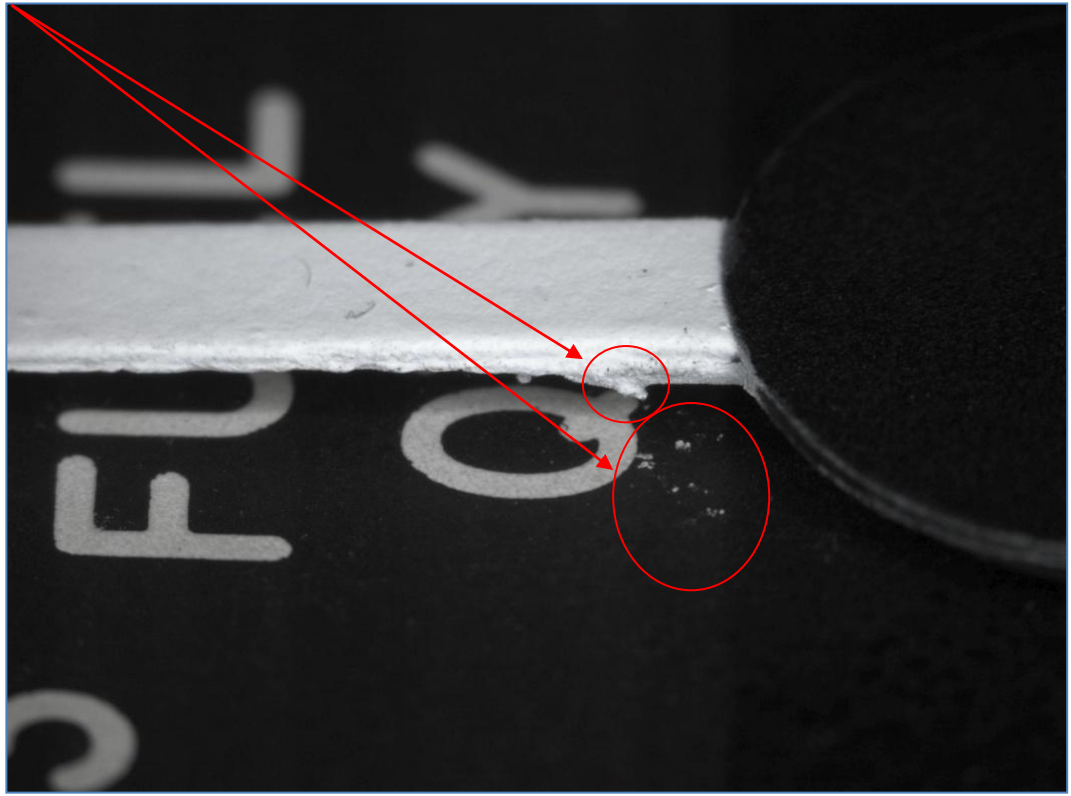
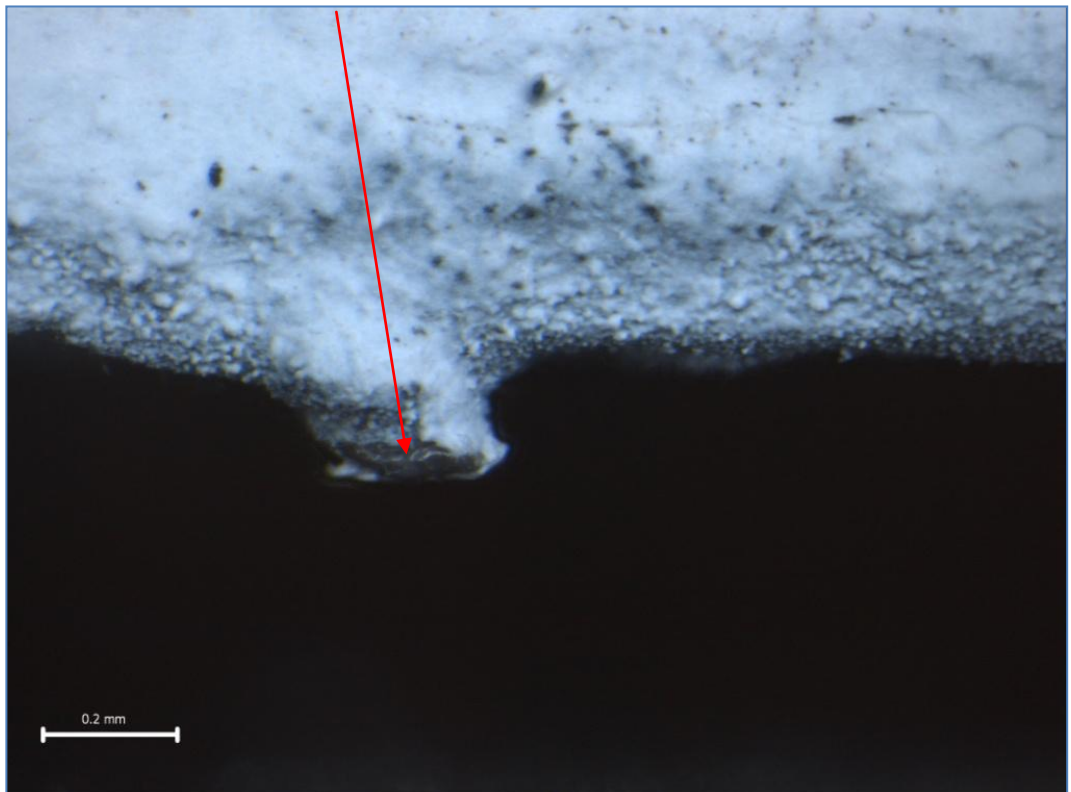
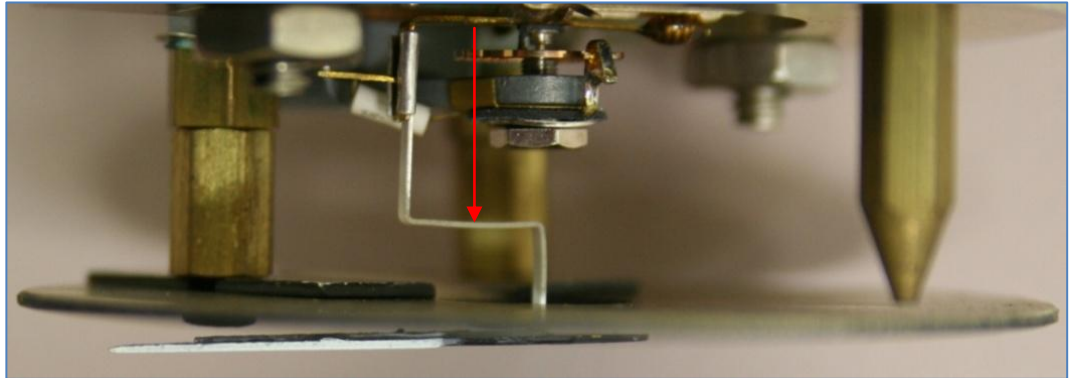


Figure 7: Paint missing from the protrusion



The instrument pointer mechanism, by virtue of its design, was very flexible in the axial direction (Figure 8), and an absence of other witness marks on the instrument face suggested that the marks found were the result of a single or ‘bouncing’ contact event.

Figure 8: Instrument pointer mechanism



Turbine outlet temperature gauge

The face of the turbine outlet temperature (TOT) gauge was visually examined for scratch marks, paint deposits or imprints.

Under low-power magnification, scratch marks (abrasions) were observed (possibly formed on contact with the instrument pointer), starting with an irregular line at a gauge indication around 690 °C, a smooth arc downwards to approximately 250 °C and another smooth arc from approximately 450 °C down to 250 °C (Figures 9, 10 and 11).

Figure 9: Start of irregular line scratch mark

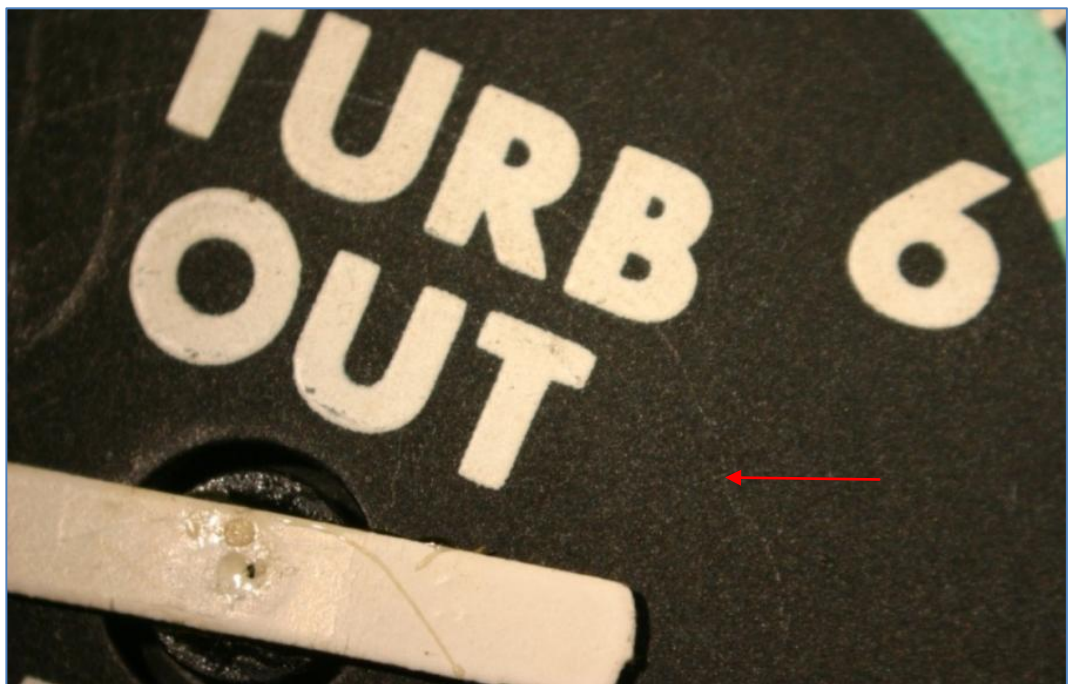


Figure 10: Smooth arc scratch marks

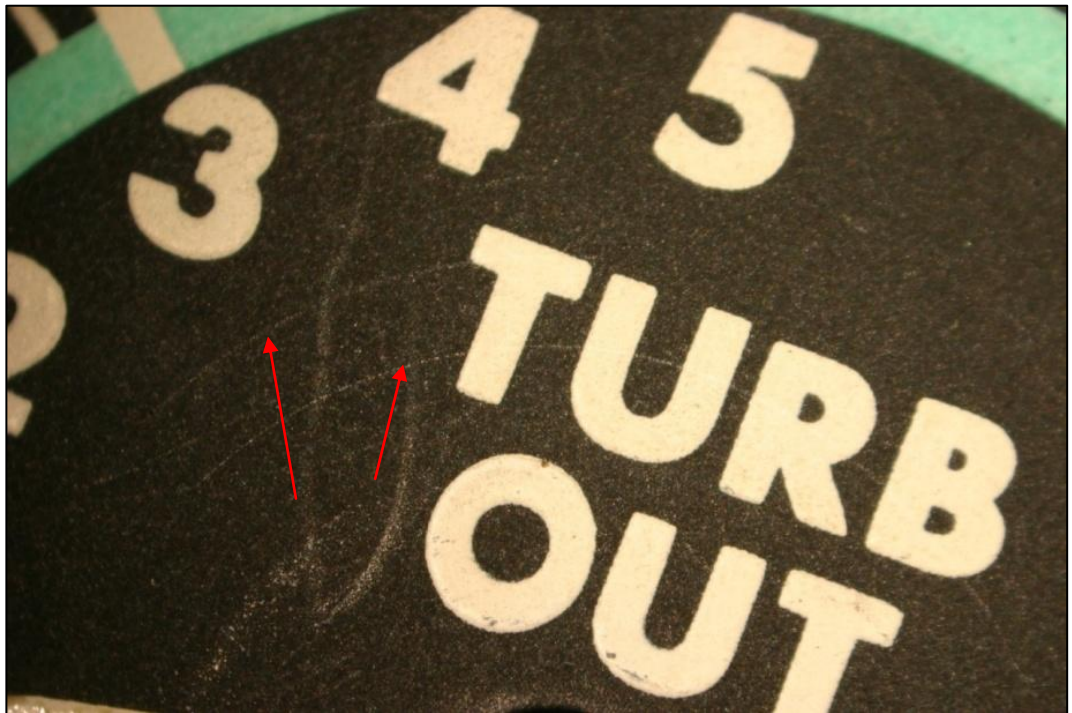


Figure 11: Pointer positioned at start of witness mark



The irregular nature of the line formed on the instrument face was common to many other witness marks found during previous instrument examinations conducted by the ATSB.

Figures 12 and 13 present data for the turbine outlet temperature, as extracted from the aircraft manufacturer's flight manual¹.

Figure 12: Published Bell Helicopter TOT temperature ranges







TURBINE OUTLET TEMPERATURE		
	100 to 716°C	Continuous Operation
	716 to 768°C	5 minute takeoff range
	768°C	Maximum for takeoff
	826°C	Beginning of time limited range for starting.
	927°C	Maximum for start and shutdown (1 second maximum)
	Warning light	Illuminates when TOT between 826 and 927°C more than 10 seconds or TOT above 927°C.

Figure 13: Turbine out temperature gauge diagram



¹ Bell Helicopter Flight Manual BHT-206L4-FM-1 Rev 4 Page 1-16.

Warning annunciator panel

The individual light globes from the annunciator panel were examined for evidence of filament stretch, which may suggest illumination at the time of terrain impact.

Many factors can influence the degree of filament deformation sustained during an accident, including:

- magnitude of impact
- direction of impact
- aircraft crumple characteristics
- age of the light globe
- illumination time both at the time of impact and total illumination time since new
- cold-stretch characteristics.

The examination found no confirmed evidence of filament stretch on any of the warning light globes from the annunciator panel.

Figures 14 and 15 compare an exemplar lamp showing confirmed filament stretch, with one of the light globes from the annunciator panel examined.

Figure 14: Confirmed filament stretch example from another accident

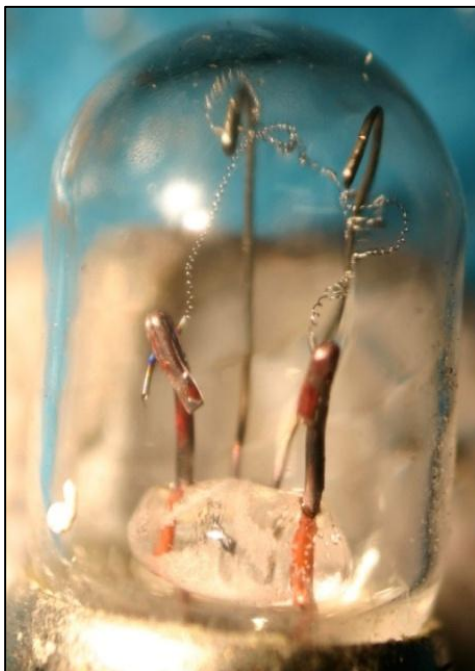
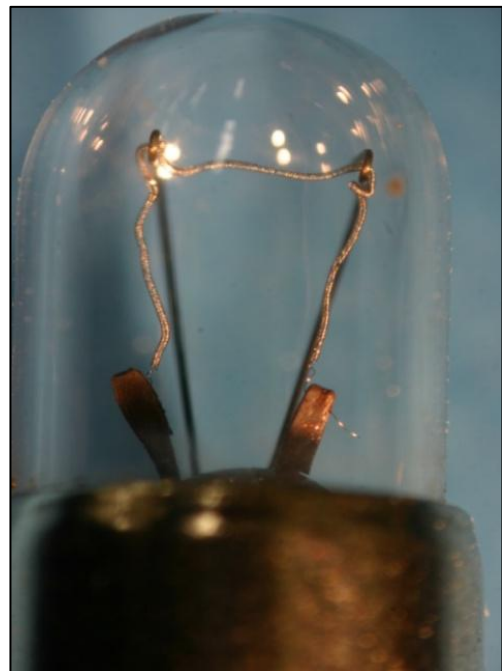


Figure 15: Warning annunciator globe from P2-HBC no filament stretch.



Fuel system detritus

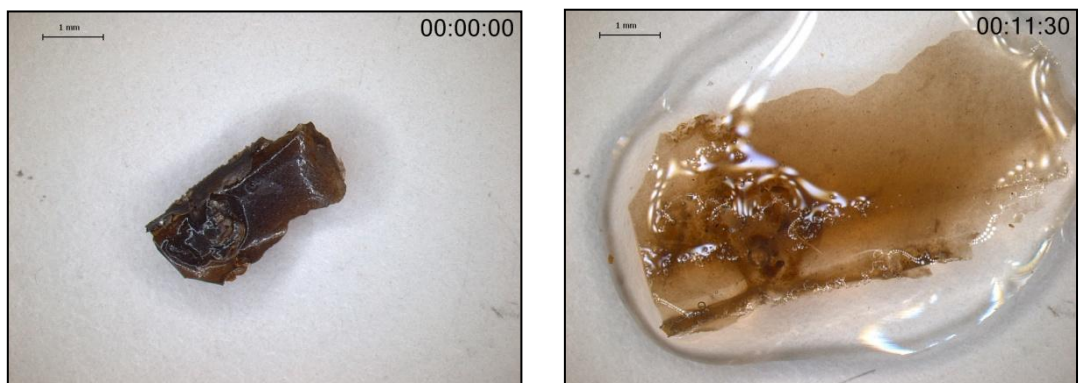
Unaided visual and low-power microscopic examination of the samples of material recovered from the helicopter's fuel system characterised the substance as a brown, semi-translucent material, with an amorphous, glassy lustre and brittle nature. The samples were of a shape that suggested they had formed around the inside surfaces of a pipe, tube or other cylindrical duct (Figure 16).

Figure 16: Typical appearance of the fuel system detritus at low-magnification



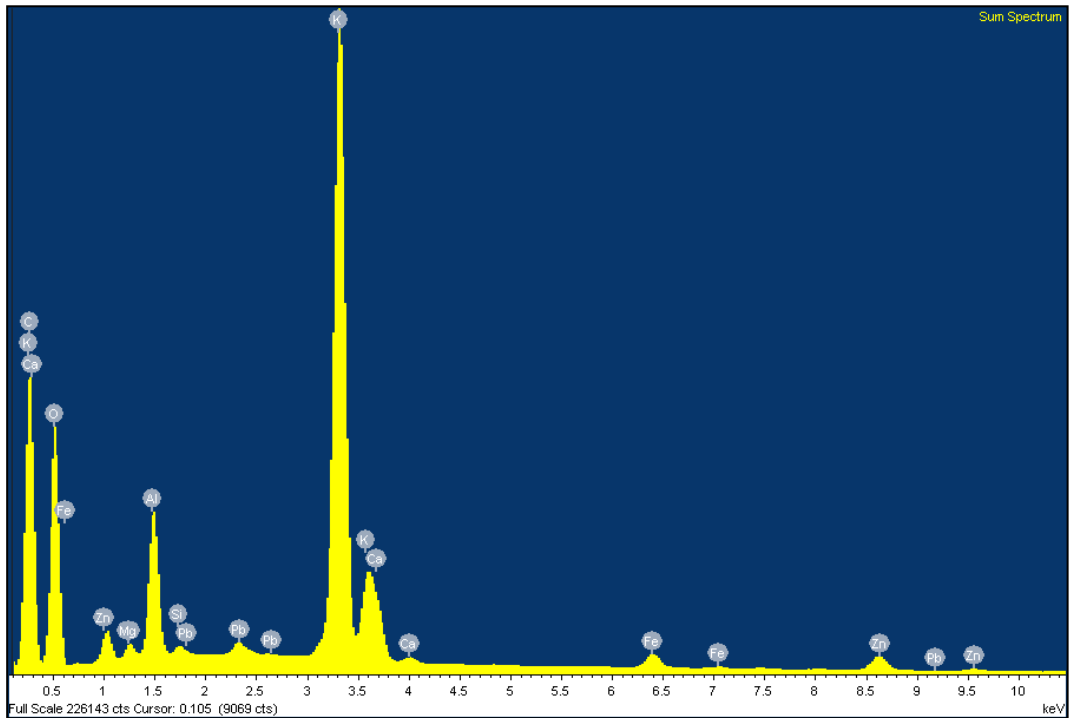
Water solubility tests found that the material hydrated and expanded rapidly when introduced to demineralised water (Figure 17) – eventually dissolving completely to form a light-brown solute.

Figure 17: Behaviour of a sample of the fuel system substance when introduced to water - time of exposure is in the right upper corner.



Elemental microanalysis of a sub-sample of the material using scanning electron microscope-energy dispersive spectroscopy (SEM-EDS) techniques identified major compositional peaks for calcium (Ca), potassium (K), aluminium (Al), carbon (C) and oxygen (O). Minor peaks for zinc (Zn), magnesium (Mg), silicon (Si), iron (Fe) and lead (Pb) were also apparent.

Figure 18: SEM-EDS spectrum of the fuel system material



ANALYSIS

The analysis and comments following relate specifically to the Australian Transport Safety Bureau's (ATSB's) technical examination of the components and materials received from the PNG Accident Investigation Commission (AIC).

This report is intended for use by the AIC in their investigation of the subject accident. The full accident investigation report will be published by the AIC when completed.

Fuel quantity indicator gauge

Examination of the fuel quantity indicating gauge found evidence of witness marks on the face of the instrument in the form of paint transfer from a protrusion on the underside of the instrument pointer, possibly from a single contact event. The witness marks corresponded to an approximate indication of 300 to 330 lb of fuel.

The examination could not determine the accuracy of the indication with respect to the fuel quantity on board the aircraft, as the gauge was the only part of the fuel quantity indicating system examined.

It is possible that aircraft attitude and fuel quantity sender unit positions could have influenced the gauge indication. The possibility that the marks may have been formed at some other time cannot be discounted.

Turbine outlet temperature gauge

Examination of the turbine outlet temperature (TOT) gauge found circumferential witness marks on the face of the instrument indicating significant movement of the gauge needle while in contact with the gauge face.

The range of temperatures indicated by the witness marks on the accident gauge were within the manufacturer's normal operating limits for the engine.

The witness marks possibly indicate initial impact starting at the beginning of the irregular witness mark at 690 °C. It is likely that bending of the pointer in a forward direction towards the instrument face, resulted in contact between the pointer and the face of the instrument at the time of impact, leaving smooth circumferential marks down to 250 °C.

The irregular start to the witness mark is probably indicative of the type of impact to which the aircraft was subjected during the accident event. Prior experience in ATSB examinations of post-accident instruments has shown that these types of witness marks can be an indication of the position and travel of the gauge pointer during, and immediately following the accident event.

Annunciator light globes

Examination of the warning light globes in the annunciator panel found no evidence of filament stretch that might suggest illumination of any of the warning lights at impact.

Fuel system detritus

The small sample of material recovered from the helicopter's fuel system was entirely consistent with being a dried microbial biopolymer mass. Colour, appearance and solubility were all characteristic of this type of product, with the elemental composition suggesting possible presence of corrosion products entrained within the film.

Biopolymer films can form within aircraft fuel systems in the presence of water – either introduced with the fuel intake, or as condensate within the void-spaces in fuel tanks and reservoirs. Such films typically form at the water-fuel interface, and as they grow, they can slough-off biomass, which will accumulate in filters and orifices, contributing to premature plugging and restriction².

² ASTM MNL47 'Fuel and Fuel System Microbiology – Fundamentals, Diagnosis and Contamination Control'.

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