ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT

AIC 20-2003

HEVILIFT (PNG) Aviation Limited

P2-KSY

DHC-6-400 Twin Otter

In-flight smoke event

Mount Hagen, Western Highlands Province

Papua New Guinea

18 October 2020

About the AIC

The Accident Investigation Commission (AIC) is an independent statutory agency within Papua New Guinea (PNG). The AIC is governed by a Commission and is entirely separate from the judiciary, transport regulators, policy makers and service providers. The AIC's function is to improve safety and public confidence in the aviation mode of transport through excellence in: independent investigation of aviation accidents and other safety occurrences within the aviation system; safety data recording and analysis; and fostering safety awareness, knowledge and action.

The AIC is responsible for investigating accidents and other transport safety matters involving civil aviation in PNG, as well as participating in overseas investigations involving PNG registered aircraft. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The AIC performs its functions in accordance with the provisions of the *PNG Civil Aviation Act 2000 (As Amended)*, and the *Commissions of Inquiry Act 1951*, and in accordance with *Annex 13* to the *Convention on International Civil Aviation*.

The objective of a safety investigation is to identify and reduce safety-related risk. AIC investigations determine and communicate the safety factors related to the transport safety matter being investigated.

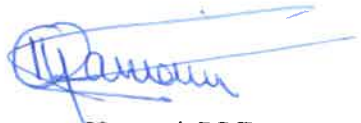
It is not a function of the AIC to apportion blame or determine liability. At the same time, an investigation report must include relevant factual material of sufficient weight to support the analysis and findings. At all times the AIC endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why it happened, in a fair and unbiased manner.

About this report

On 19 October 2020 at 12:09 local time (02:09 UTC), the AIC was notified by the Civil Aviation Safety Authority of Papua New Guinea (CASA PNG), via a phone call, about a serious incident that occurred on 18 October 2020, involving a DHC-6-400 (Twin Otter) aircraft, registered P2-KSY, owned and operated by Hevilift (PNG) Aviation Limited. During the initial inquiries, the AIC established that the aircraft was subject to post occurrence maintenance action and subsequently released back to service before the AIC was made aware of the occurrence. The AIC immediately commenced an off-site investigation. The report is in a short format and focuses on the relevant aspects of the investigation; Operations, maintenance, hydraulic system and organisational information.

This *Final Aircraft Accident Investigation Report* has been produced by the PNG AIC and is publicly released by the Commission pursuant to *ICAO Annex 13, Chapter 6, paragraph 6.5*. This report is published on the AIC website: www.aic.gov.pg.

The report is based on the investigation carried out by the AIC in accordance with Papua New Guinea *Civil Aviation Act 2000 (As Amended), Annex 13* to the *Convention on International Civil Aviation,* and the *PNG AIC Investigation Policy and Procedures Manual*. It contains factual information, analysis of that information, findings and contributing (causal) factors, other factors, safety actions, and a safety recommendation.



Hubert Namani, LLB
Chief Commissioner

21 September 2021

Smoke in the cockpit

Occurrence Details

On 18 October 2020, at about 08:54 local time (17 October 2020 at 22:54 UTC[1]), the crew of a DHC-6-400 Twin Otter aircraft, registered P2-KSY, operated by Hevilift (PNG) Aviation Limited, identified the presence of smoke in the cockpit while overflying Mount Hagen Airport, Mount Hagen, Western Highlands Province, following a discontinued approach to runway 30.

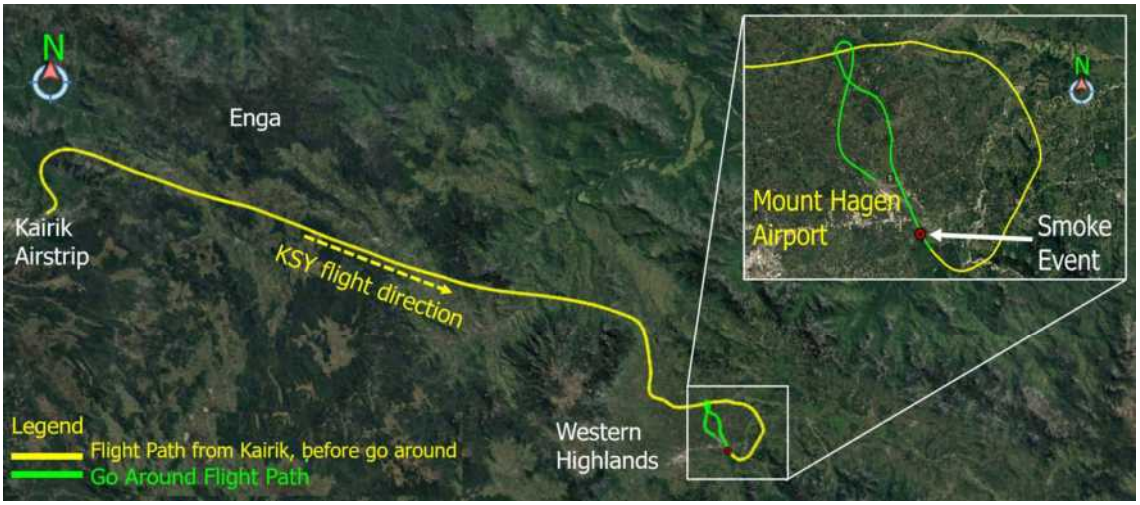


Figure 1: P2-KSY flight path from Kairik to Mount Hagen.

The aircraft was on an IFR passenger charter flight from Kairik, Enga Province. The pilot in command (PIC) was the designated pilot flying. The co-pilot was pilot monitoring.

According to the Flight Data Recorder (FDR) data, about 34 nm from Mt. Hagen, at 08:34:55, hydraulic pressure spiked up to 1,888 psi and remained above 1,575 psi for about 9 minutes. At 08:49:01, about 4nm from Mt. Hagen, the pressure spiked again up to 1,900 psi and remained above 1,575 psi for about 9 minutes. Information about hydraulic pressure is constantly available to the crew through the multi-function display unit (MFDU). However, there was no evidence that the crew noticed these abnormal parameters or that they reacted to them.

About 12 nm North West of Mount Hagen Airport, the crew established contact with Hagen Tower. The crew were instructed to track to the Komun area for an approach to runway 30 and were provided with weather and air traffic information. The aircraft established over Komun at about 08:53, at a height of 1,500 ft AGL[2] (6,900 ft AMSL) (see Figure 2).

The crew stated that they subsequently turned the aircraft right for the approach, but they decided not to descend due to low cloud along the approach path. Instead, they continued tracking towards the runway at the same height. Just over 1 nm from the runway, the crew called Hagen Tower and reported that they did not have the runway in sight at that point. Hagen Tower subsequently instructed the crew to go around and track towards the Baiyer.

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1 The 24-hour clock, in Coordinated Universal Time (UTC), is used in this report to describe the local time as specific events occurred. Local time in the area of the serious incident, Papua New Guinea Time (Pacific/Port Moresby Time) is UTC + 10 hours.

2 Above Ground level (AGL), referenced to the Mount Hagen Airport elevation of 5,386 ft as per the Papua New Guinea Aeronautical Information Publication.

In the interview with the AIC, the crew reported that as they were approaching overhead the aerodrome, they noticed a smoke smell in the cockpit. The co-pilot turned to check the cabin, but he did not observe any smoke in the cabin.

According to the FDR data, at 08:54:36, tracking to overfly the aerodrome, maintaining 1,500 ft AGL, the Crew Alerting System[3] (CAS) *Hydraulic Power Failure Warning* message displayed on the MFDU along with the *Master Warning*[4] activation. At that time, the actual hydraulic Brake Pressure was 1760 psi, and the System Pressure was about 1784 psi.

The crew stated that subsequent to receiving the hydraulic system related CAS alerts, they observed pressure readings on the MFDU indicating sufficient System Pressure and high Brake Pressure.

At 08:55:09, as the aircraft passed overhead the aerodrome, tracking North towards the Baiyer, the *Hydraulic Pump Over Temp Caution* activated along with the *Master Caution*.

The crew confirmed that the smoke smell in the cockpit continued to intensify, and the co-pilot recalled observing a thin wisp of smoke coming from the cockpit floor on the right side of the co-pilot's yoke. The co-pilot notified the PIC of the presence of smoke in the cockpit and proceeded to slide his window down while the PIC opened the vents allowing the smoke to disperse. At this time, the aircraft was tracking outbound towards the Baiyer area.

The PIC stated that he decided not to apply any abnormal or emergency procedure as the aircraft appeared stable, the MFDU hydraulic pressure readings showed that there was very high brake pressure and sufficient system pressure available, and also to avoid the use of the manual hand pump to maintain hydraulic pressure.

At 08:55:44, less than 1 nm North of the airfield, outbound towards the Baiyer area, the crew requested for an approach to runway 12, adding that they were experiencing an in-flight emergency. Hagen Tower instructed the crew to continue tracking towards the Baiyer and hold. The crew responded to Hagen Tower notifying them of a hydraulic problem with possible smoke and, again, requested to land on runway 12.

At 08:56:16, the crew reported to Hagen Tower that they were 2 nm from the field and requested to turn inbound and track for runway 12. The crew also requested for weather on runway 12. Hagen Tower subsequently instructed the crew to report when turning inbound and provided the weather for runway 12.

At 08:58:01, Hagen Tower contacted Aviation Rescue Fire Fighting Services (ARFFS) and requested them to be on standby for P2-KSY. According to the ARFFS incident report, their team was immediately dispatched to standby at taxiway Alpha.

Following Hagen Tower's clearance, at about 4 nm North West of the airfield, 1,300 ft AGL, the crew conducted a right turn and began tracking South West to intercept the approach path for runway 12. The crew also commenced a shallow descent as they tracked towards the South West. The PIC stated during interview that they carried out the *Final Approach* checklist setting the aircraft flap to 20 degrees, propellers to maximum rpm and maintaining a final approach speed between 75-80 kt. The PIC briefed the co-pilot about the landing and use of reverse thrust.

FDR data showed that when the flight crew extended flaps to 20º during final approach, a rapid decrease in the hydraulic system pressure occurred.

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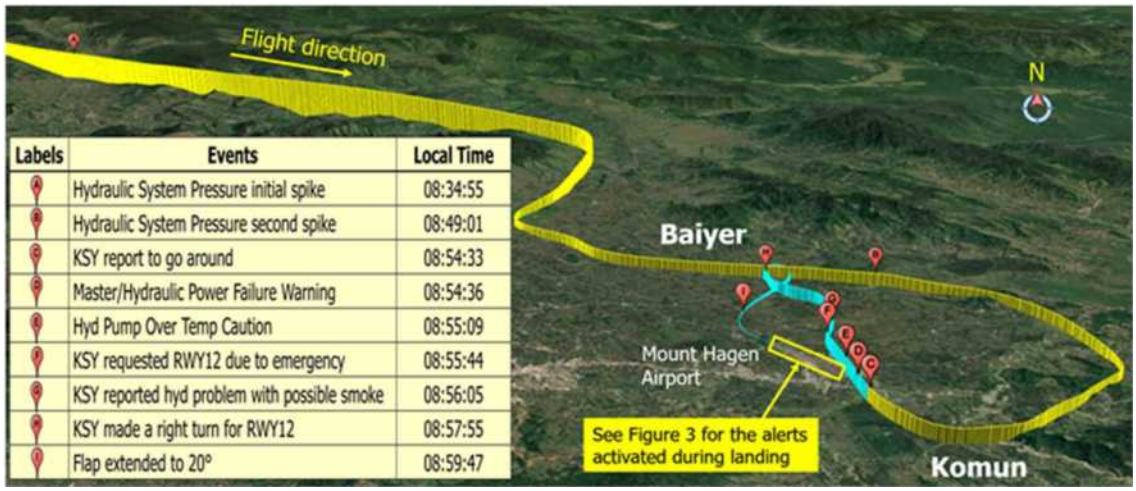
3 See Crew Alerting System section of this report.

4 The red MASTER WARNING switchlight provided directly above each pilot's primary flight display will illuminate whenever a Warning CAS Message appears, together with a triple chime. **Source:** *Section 7 of DHC-6-400 AFM*.



Labels	Events	Local Time
	Hydraulic System Pressure initial spike	08:34:55
	Hydraulic System Pressure second spike	08:49:01
	KSY report to go around	08:54:33
	Master/Hydraulic Power Failure Warning	08:54:36
	Hyd Pump Over Temp Caution	08:55:09
	KSY requested RWY12 due to emergency	08:55:44
	KSY reported hyd problem with possible smoke	08:56:05
	KSY made a right turn for RWY12	08:57:55
	Flap extended to 20°	08:59:47

Figure 2: P2-KSY flight path with significant events.

At 09:00:20, about 300 ft AGL, the aircraft turned left, onto the final approach. According to the FDR data, the aircraft touched down at 09:00:57. The FDR data showed that the *Hydraulic Press Low Caution* was activated at 09:01:10 during the landing roll. Three seconds later, the *Hydraulic Press Low Warning* and the *Master Warning* activated. The data also showed that reverse thrust was applied during the landing roll.

After completing the landing roll, the crew used asymmetric power and nose wheel steering to taxi and exit via taxiway Bravo and to the parking bay, where engines were shut down and a normal disembarkation was conducted. The ARFFS team entered the runway from taxiway Alpha and escorted the aircraft from behind.

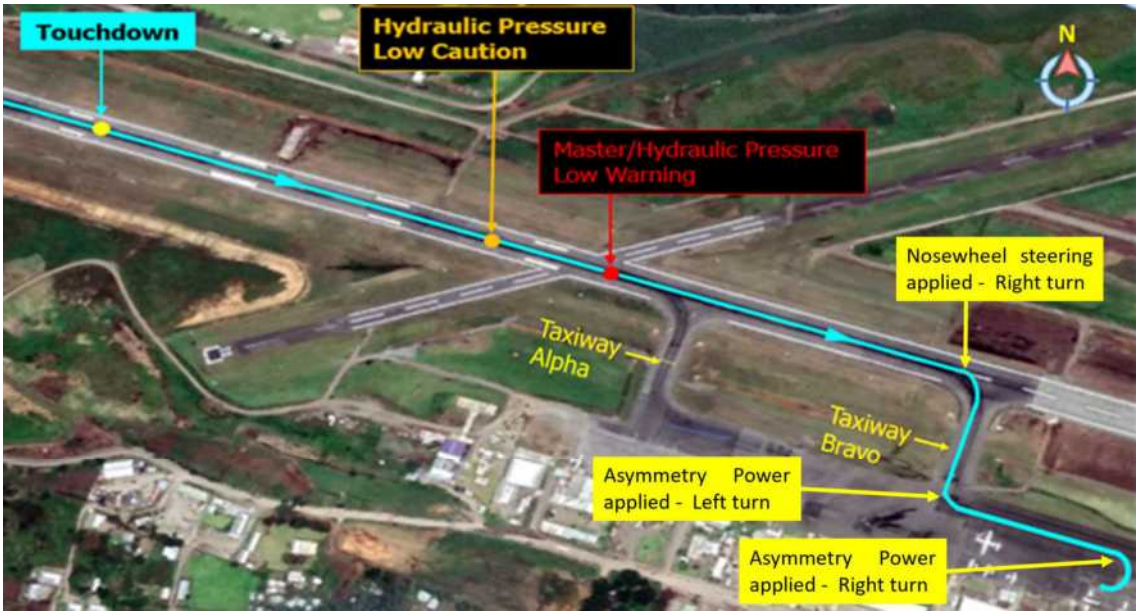


Figure 3: Alerts activated during landing roll.

Hydraulic System

The hydraulic system is an electro-mechanical system that operates the wing flaps, wheel brakes and nose wheel steering.

The main components of the hydraulic system are a constant 28V electric motor-driven pump[5], an emergency hand pump, a reservoir, system and brake accumulators, flap and nose wheel steering actuators, brake valves, and a flap selector.

A thermal switch mounted on the electric-motor driven pump housing triggers a *CAS* caution alert *"Hyd Pump Over Temp"* when it senses the component's temperature reach about 180±5 ºF.

The system pressure is regulated by a *pressure switch* mounted on the hydraulic fluid line, which controls a *relay* which opens at 1575±50 psi to disengage the pump and closes to supply power to the pump when the pressure drops by 150-300 psi.

According to the manufacturer, when the hydraulic system pressure drops below the minimum working pressure value of 1,225 psi, it triggers a CAS caution amber alert, *"Hyd Press Low"* if the aircraft is in flight, and a CAS warning red alert, *"Hydraulic Press Low"* when the aircraft is on the ground.

In the event of failure of the electric motor-driven pump, or when a high demand of pressure is required, the system accumulator makes pressure immediately available to wheel brakes and, through their respective actuators, to the flaps and the nose-wheel steering. The brake accumulator supplements the system accumulator in supplying pressure to the brakes and maintains a reserve pressure for brake operation in the event of pressure loss from the system accumulator or failure of the electric motor-driven pump.

In the event of a hydraulic pressure loss, an emergency hand pump installed in the cockpit allows restoring sufficient pressure in the system.

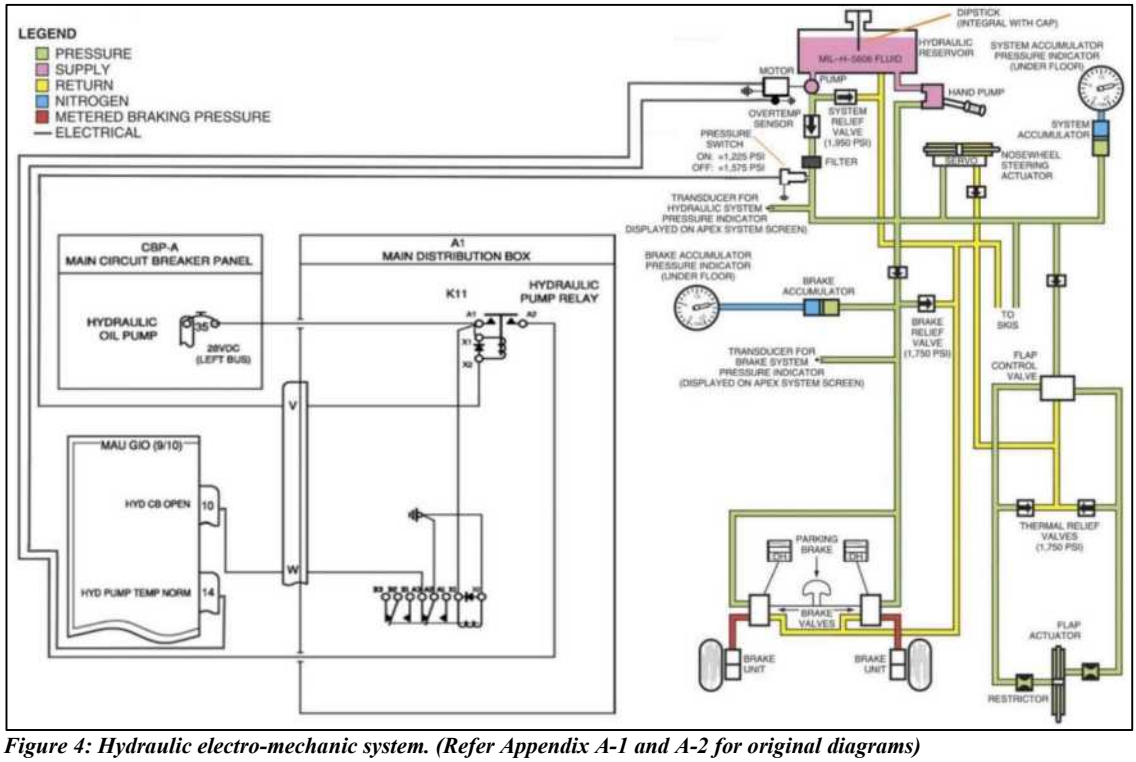


Figure 4: Hydraulic electro-mechanic system. (Refer Appendix A-1 and A-2 for original diagrams)

5 The term electric motor-driven pump is used interchangeably with the term "hydraulic pump" in this report.

Crew Alerting System

The aircraft was equipped with CAS for providing visual alerts to the crew in the cockpit regarding malfunctions or abnormal conditions which occur during operation. Warning messages are accompanied by a red *MASTER WARNING* light and sounding of a triple chime. Caution messages are accompanied by an amber *MASTER CAUTION* light and sounding of a single chime.

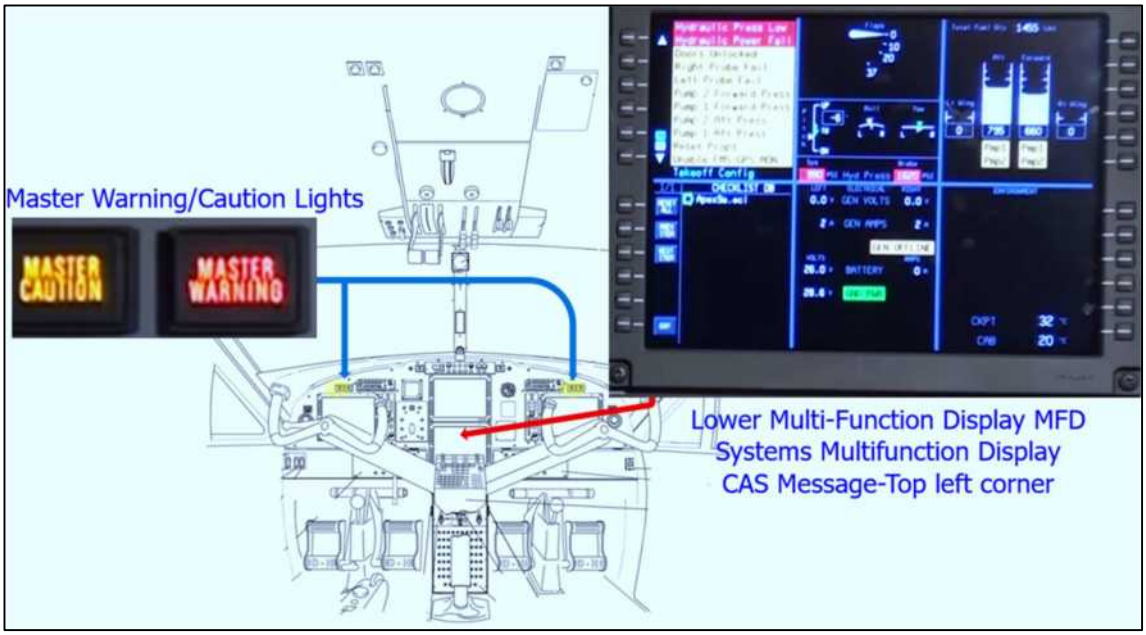


Figure 5: Crew alerting system display.

The CAS messages are grouped by severity into four priority levels: warning messages (red), caution messages (amber), advisory messages (cyan), and status messages (white). The CAS warning and caution messages received by the crew regarding hydraulic system abnormalities are shown below.

Activation time (FDR)	Level	CAS Message	Probable Cause as per DHC-6-400 AFM
08:54:36	Warning	Hydraulic Power Fail	HYDRAULIC OIL PUMP circuit breaker (position C6) has been pulled out, or for some other reason, electrical power is not available to the hydraulic oil pump.
08:55:09	Caution	Hyd Pump Over Temp	Electric hydraulic pump has overheated.
09:01:11	Caution	Hydraulic Press Low	System hydraulic pressure is less than 1,225 psi and the aircraft is in flight.
09:01:14	Warning	Hydraulic Press Low	System hydraulic pressure is less than 1,225 psi when aircraft is on ground.

Table 1: Hydraulic system CAS messages and associated probable causes. (Source: DHC-6-400 AFM)

Serviceability

According to the maintenance records, the aircraft was serviceable at the time of the serious incident.

Maintenance

Note: This section is limited to maintenance related to the hydraulic system.

The review of the maintenance records from six months prior to the occurrence, and information gathered in addition to it allowed AIC to identify that during the aircraft operation on 26 August 2020, there was a spike in hydraulic pressure in-flight. Once landed, the pilot observed the brake pressure gauge on the hydraulic power pack, identifying a reading of 1,800 psi, while the system accumulator pre-charge pressure was 400 psi. This was reported to Hevilift Engineering who advised the pilot to conduct a restart. The aircraft's hydraulic system was reported to be functioning normally after the restart, and the aircraft continued its operation.

However, on 27 August 2020, the *Master Warning* and *Hydraulic Power Failure Warning* CAS message activated in the cockpit in-flight. The brake pressure was observed in the cockpit to be 1,500 psi while the system pressure was stated to be below the minimum working pressure value. A normal landing was conducted with the use of the emergency hand pump to maintain adequate pressure for nose wheel steering and braking. The pilot of that flight reported that on the ground, gentle tapping of the pressure switch assisted the hydraulic system to operate normally and after relaying these issues to Hevilift Engineering he continued with the remaining two flights, in one of which a similar issue was reported.

Maintenance was subsequently carried out on 28 August 2020 by a licensed aircraft maintenance engineer (LAME) to rectify the reported defect. Table 2 below is a representation of maintenance carried out on the aircraft's hydraulic system since 28 August 2020.

Maintenance Log #	Item	Date	Defect	Action taken		P/N	S/N
10674	B	28 August 2020	System hydraulic accumulator leaking.	Accumulator replaced with serviceable part. Operation and Leak checks carried out IAW Chapter 29-00-00 of the AMM.	Removed:	088421-010	8421-28177
					Installed:	088421-010	8421
10674	C	28 August 2020	Hydraulic pump pressure switch intermittent operation.	Pressure switch replaced with serviceable part. Operation and Leak checks carried out IAW Chapter 29-00-00 of the AMM.	Removed:	PDM6607P9-6A	216
					Installed:	PDM6607P9-6A	672
10676	A	06 September 2020	Hydraulic pump unserviceable.	Hydraulic pump replaced. Operational check carried out. Hydraulic system topped up and bled. Maintenance carried out IAW Chapter 29-10-41 of the AMM.	Removed:	AAT-600-029-100-1	108
					Installed:	AAT-600-029-100-1	182
10684	C	15 October 2020	Hydraulic brake and system accumulators low pressure @500+ psi.	Both accumulators re-charged to nominal pressure of 800 psi IAW Chapter 32-40-51 of the AMM.	Removed:		
					Installed:		

Table 2: Maintenance carried out on the aircraft hydraulic system between May and October 2020.

Post Occurrence Action – Systems and components

Following the occurrence on 18 October 2020 and before AIC was notified, the Operator LAMEs carried out unscheduled maintenance on the aircraft and subsequently released the aircraft to service on the same day. Table 3 below is a representation of the defects identified on the aircraft's hydraulic system by the Operator.

Maintenance Log #	Item	Date	Defect	Action taken		P/N	S/N
10687	A	18 October 2020	Hydraulic pump stuck "on" in flight. Smoke entered cockpit.	Hydraulic pump replaced with new item. Operational and leak check carried out IAW Chapter 29-00-00 of the AMM.	Removed:	C6NF2264-1	182
					Installed:	C6NF2264-1	80
10687	B	18 October 2020	Refer Item A - Hydraulic pump relay shut closed.	Hydraulic pump relay replaced with new item. Tested serviceable IAW Chapter 20-10-00 of the AMM. Refer Item A.	Removed:	MS24166D-1	
					Installed:	MS24166D-1	

Table 3: Post occurrence maintenance carried out on the hydraulic system.

The hydraulic pump (S/N: 0182) was sent to the component manufacturer[6], where a bench test and tear down inspection was conducted. Refer *Bench Test Report* section.

According to the LAME statement, when the relay was disassembled from the hydraulic power pack and removed, it was identified that its contacts had welded in the closed position.

The AIC received the relay from the Operator and identified that the relay contacts were able to be separated without effort. Upon inspection, no sign of welding was observed. The investigation determined that the pitting deformation identified on the contacts was a result of arcing which is generally a normal unavoidable contact wear process in electromagnetic relays such as the one shown below. This occurs when the electromagnetic flux of a relay deenergises inducing a reverse voltage that maintains electric current between the relay contacts as they open.

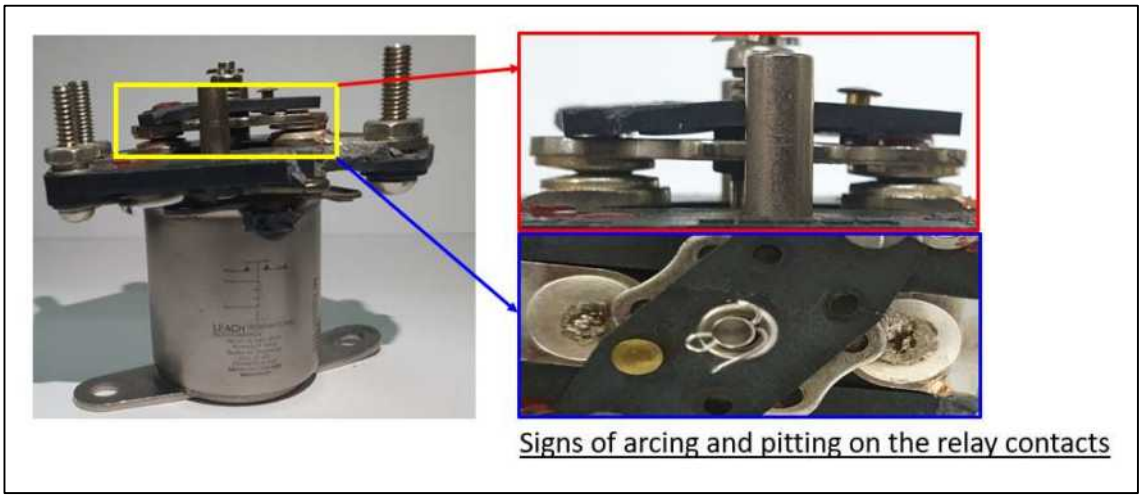


Figure 6: Relay removed from aircraft during post-occurrence maintenance.

Type certificated Hydraulic Pump part number

The AIC identified that the hydraulic pump installed on the aircraft at the time of the occurrence was part number AAT-600-029-100-1, which according to the maintenance records had been fitted on the aircraft on 6 September 2020. It was also observed that on 18 October 2020, during post occurrence maintenance, the hydraulic pump removed from the aircraft had the part number C6NF2264-1.

6 Texas Air Services Inc.

According to the Operator, the annotation of two different part numbers was due to an oversight by maintenance staff when logging the maintenance conducted on 6 September 2020.

According to the component manufacturer, Texas Air Services Inc. (TAS), the hydraulic pump part AAT-600-029-100-1 is approved for installation under a supplemental type certificate, held by TAS, on the DHC-6-100/200/300 series aircraft. On the DHC-6 Series 400, the hydraulic pump type certified by Viking for installation is part number C6NF2264-1. This pump is manufactured from part number AAT-600-029-100-1 with a modification to the wiring completed in accordance with Viking Technical Bulletin TBV6/00031 (see Appendix B).

The AIC identified that a rework was done on the hydraulic pump installed on the aircraft. However, the Operator did not provide supporting evidence to confirm if the rework was carried out in compliance with Viking Technical bulletin *TBV6/00031*.

Bench Test Report

On 2 December 2020, TAS conducted a bench test for hydraulic pump, S/N: 0182. According to the manufacturer, the unit ran for 1 second during the bench test before the circuit breaker popped. The manufacturer subsequently tore down the unit and made the findings listed in Table 4 below.

No.	Finding	Method
1	Brushes worn about 10%	visual inspection
2	Bearings are rough	visual inspection
3	Armature short circuited	growl test

Table 4: Findings from the electric motor-driven pump tear down

Figure 7 is a schematic of the electric motor and components listed in Table 4.

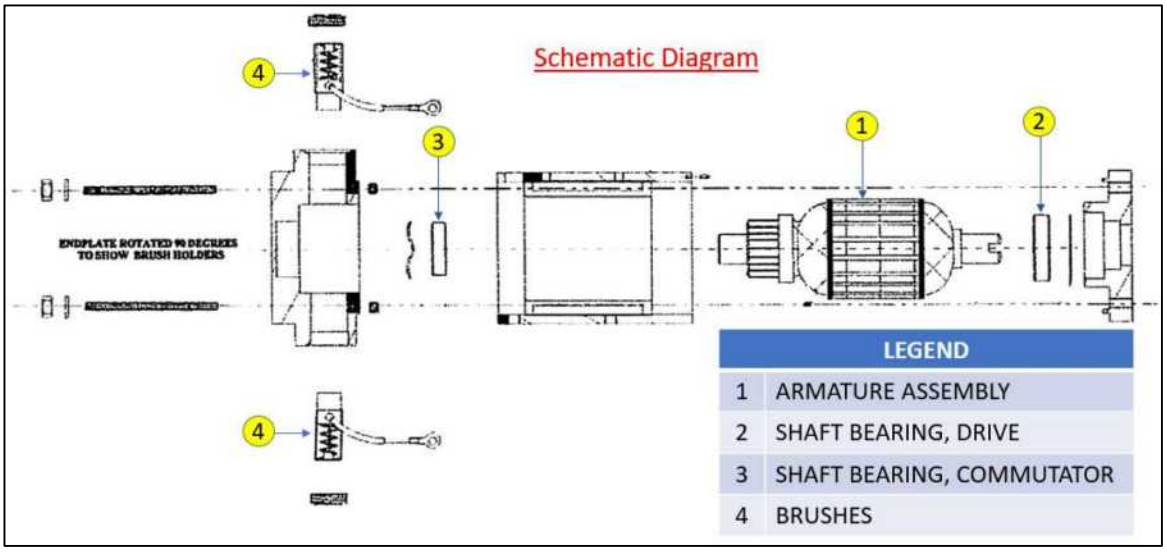


Figure 7: Electric motor schematic diagram.

Flight Recorders

The aircraft was fitted with a cockpit voice recorder (CVR) and a flight data recorder (FDR). Both recorders were solid-state and manufactured by Honeywell. On 22 October 2020 the FDR was the only

recorder downloaded by AIC. The CVR was not downloaded as occurrence data was already overwritten by new recorded data.

The FDR had a recording capacity of more than 25 hours and was recording data at a rate of 256 words per second. The key parameters to the occurrence were the hydraulic system parameters and its associated alerts. Additional parameters such as Pressure Altitude, Latitude, Longitude, Magnetic Heading and Time were also used to complement the key parameters as shown in Figures 8 and 9.

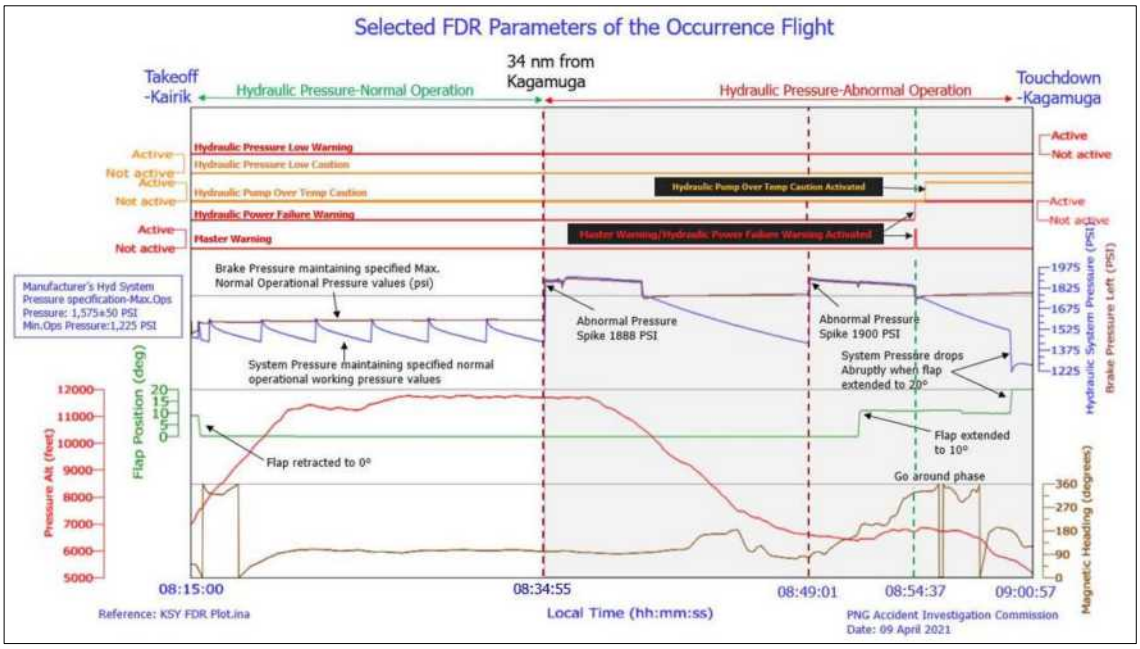


Figure 8: FDR Recorded parameters of the occurrence flight from take-off to touchdown.

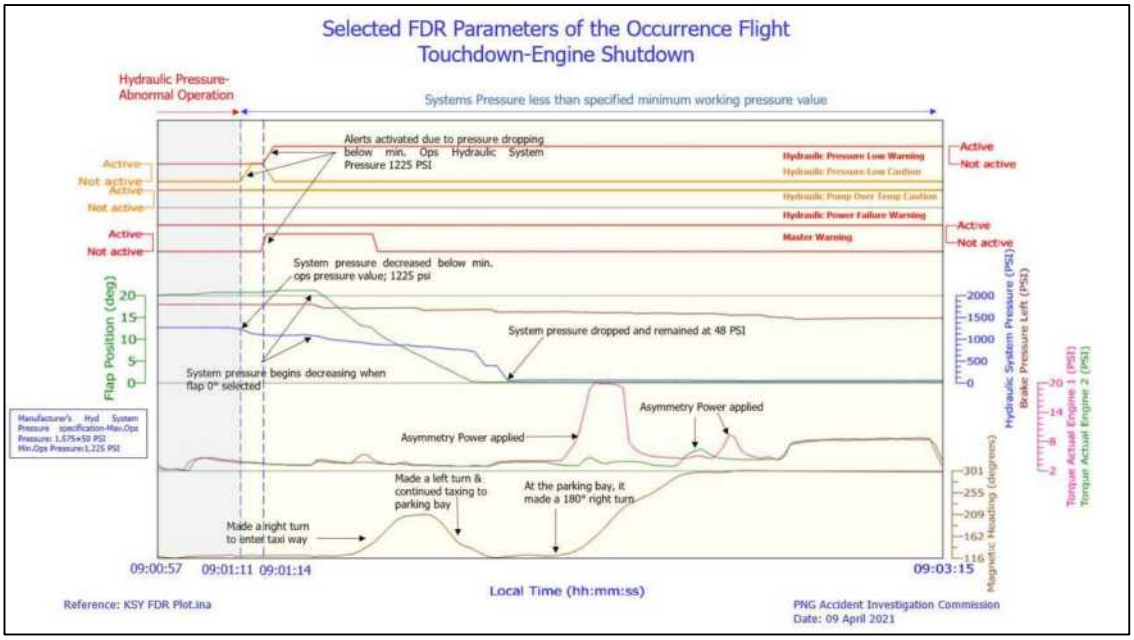


Figure 9: FDR Recorded parameters of the occurrence flight from touchdown to complete stop.

Viking Air Limited All Operators Message

On 8 March 2018, Viking Air Limited issued an *All Operators Message DHC-6-AOM-29-001* (AOM) (see Appendix C) based on previous reports of the hydraulic system pressure switch failing in the "ON[7]" position resulting in a continuously running electric motor-driven pump and subsequent overheating of the electric motor-driven pump. They also highlighted the use of an existing abnormal procedure; *Hydraulic System Pump/Motor Over Temp,* contained in the *Aircraft Flight Manual* (AFM).

The AOM provided an interim directive to operators of the *DHC-6-400* requiring them to disseminate the information contained in the AOM to flight crews. As a result of the directive, crews were required to action the *Hydraulic Pump Over Temp* abnormal procedure already existing in section 3.16.2 (see Appendix D) of the AFM in the event of the following:

1. *Smoke and/or fumes are observed in the cockpit, and a simultaneous sustained system hydraulic pressure of greater than 1575 psi is observed; or*
2. *If a sustained system hydraulic pressure of greater than 1575 psi is observed.*

According to the Viking portal, Viking's AFM that was current at the time and appropriately specified the procedure, was revision 3, effective on 8 February 2017.

At the time of the occurrence, Viking's Quick Reference Handbook (QRH) Issue 3 was current (effective date 7 March 2019). It contained the *Hydraulic Pump Over Temp* abnormal procedure (see Appendix E).

Organisational Information

Hevilift (PNG) Aviation Limited

Hevilift (PNG) Aviation Limited, is a fixed wing and rotary wing aircraft service provider based in Mount Hagen, Western Highlands Province. According to its Air Operator's Certificate, Hevilift (PNG) Aviation Limited is authorised to perform commercial operations in accordance with its exposition and Civil Aviation Rule (CAR) Parts 121 Large Aeroplanes, 125 Medium Aeroplanes, and 136 Helicopters.

Hevilift (PNG) Aviation Limited also holds a Maintenance Organisation Certificate, which allows them to maintain and release to service aircraft and aircraft components under CAR Part 145.

Hevilift (PNG) Aviation Limited is a subsidiary within the Hevilift Group of Companies. According to the *Hevilift Group Policy Manual*, the Hevilift Group of Companies is governed by the management entity Hevilift Corporate Pty Ltd[8]. The management entity provides corporate services, governance and group wide policies and procedures as a standard. However, each subsidiary company is accountable for its own management and day-to-day operation.

Document Control

Pursuant to the *CAR Part 100*, *section 100.111 Document Control*, the Operator uses the *Hevilift Group Document Control Manual* (DCM), for document control.

7 The pressure switch is considered to be "ON" when it provides grounding to the relay, subsequently causing the relay contacts to close, thus producing DC power to work the electric motor-driven pump.

8 Hevilift Corporate Proprietary Limited is a company based in Australia.

According to the DCM, *Section 2.3.1 Group Document Controller*:

> *The Document Controller, as a part of the Hevilift Group Safety and Compliance department, will manage, control and maintain all the documents and records such as manuals and forms by:*
>
> *a. Processing the new release, revision and removal of obsolete registered controlled documents and forms.*
>
> *b. Maintaining the accuracy of Document Master Register, List of Controlled Documents and Air Maestro[9] controlled folders.*
>
> *c. Ensuring that latest revision is in place and obsolete versions are removed to prevent unintended use.*
>
> *d. Uploading and distribution of controlled documents and records in Air Maestro and to respective copy holders[10], if necessary.*
>
> *e. Updating and tracking of Master Register in coordination with QAS from respective bases applicable both for internal and external documents including the technical publications.*
>
> *f. Ensuring approved company standard formatting is applied.*

According to the information provided by the Operator, they did not receive the AOM. Further information they provided to the AIC indicated that the AOM was not uploaded into the Air Maestro system by the Document Controller and disseminated to relevant personnel of the Operator including flight crew.

Although the Operator was unable to provide information about whether the AOM was received by the Document Controller for processing or not, the AIC established that the AOM had been sent by Viking Air Limited via email to several Hevilift Group email addresses on 8 March 2018, the same day the AOM was issued.

The AIC also identified that the Operator's DHC-6-400 QRH in use was revision 3 (effective date 25 November 2015) which, at the time of the occurrence was outdated. It did not contain certain procedures such as the *Hydraulic Power Fail Warning* and *Hydraulic Press Low Warning* emergency procedures which the Manufacturer's current version had (see Appendix E).

Flight Operations Manual

According to the Operator's *Flight Operations Manual*, *Section 8. Standard Operating Procedures*, sub-section *8.2 General* states:

> *Prior to implementing any abnormal procedures, Captains should make a judgement as to whether in-flight rectification is necessary, or desirable, having regard to system redundancy, traffic and weather conditions, flight time to destination and the extent to which the normal operation of the aircraft is affected.*

The PIC stated during interview that based on his judgement at the time of the occurrence, he focused on landing as soon as practicable following the recognition of the hydraulic system abnormalities, instead of carrying out related emergency procedures.

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9 Air Maestro is a cloud-based software used by the Operator for different purposes including document control.

10 Person(s) nominated by the organisation to acquire the manual/document and be notified of all amendment revisions. *Source: Hevilift Group Document Control Manual.*

AIC comment

The investigation determined that the two consecutive abnormal and extended high hydraulic pressure cycles that were sustained in flight were due to the inconsistent operation of the pressure switch causing the relay switch to remain engaged and continue operating the hydraulic pump beyond its normal operation limit. The AIC observed no evidence that indicates that the relay failed in operation. The deformation observed on the relay contacts was determined to be pitting due to the arcing associated with such electromagnetic devices.

The investigation also determined that the continuous high demand on the hydraulic pump as a result of the intermittent failure of the pressure switch led to a *Hyd Pump Over Temp Caution* CAS message, due to heat being generated within the component's housing. The extended operation of the hydraulic pump likely caused the significant wear of the bearings found during the examination. Additionally, a short was created in the hydraulic pump's armature causing the hydraulic pump to fail and the *Hydraulic Power Failure Warning* to activate.

Even when the Manufacturer released an AOM directing operators to ensure their pilots action the *Hydraulic Pump Over Temp* abnormal procedure under specified conditions, the investigation determined that in the context of the occurrence, that procedure was not carried out by the crew. In addition, the investigation found that the Operator's document control system did not effectively ensure that external documents and technical publications were distributed to the appropriate personnel and, in this particular case, the AOM was never brought to the knowledge of the pilots.

The lack of awareness about the AOM may have conditioned the decision made by the PIC to focus on an immediate safe landing rather than to action the checklist of respective hydraulic abnormality alerts that were received.

Additionally, the Operator's QRH that was in use at the time of the occurrence was outdated and had incomplete procedures for hydraulic abnormalities available to the flight crew.

Subsequently, during final approach, when flap was extended to 20º, the System Pressure significantly dropped, and continued to drop and, after touchdown, during the landing roll, the *Hydraulic Press Low Caution* and *Hydraulic Press Low Warning* activated.

In addition, the investigation determined that the Operator did not have the necessary records to demonstrate that the rework of the hydraulic pump was done in accordance with the Viking Technical Bulletin *TBV6/00031* before it was installed on the aircraft.

Safety Actions

On 16 April 2021, the Operator issued a memo to all its engineers in Papua New Guinea to notify them of the maintenance recording issue regarding the DCH-6-400 hydraulic pump part number as identified by the AIC. The Operator advised the engineers that all maintenance must be recorded in the maintenance log and that all applicable maintenance instructions must be followed.

On 28 May 2021, the Operator provided to the AIC an extract of its Part 125 monthly safety presentation for May 2021 which contained the contents of the Viking AOM. The Operator also provided evidence of the monthly safety presentation as being distributed to the applicable Twin Otter aircraft flight crews on the same day.

Recommendations

Recommendation number AIC 21-R04/20-2003 to Hevilift (PNG) Aviation Ltd

The PNG Accident Investigation Commission (AIC) recommends that Hevilift (PNG) Aviation Limited should ensure that its Document Control system consistently effects, maintains and implements the Operators controlled documents as appropriate, and in a timely manner, so that documents are effectively disseminated across all the relevant organisational areas and staff as appropriate.

Action requested

The AIC requests that Hevilift (PNG) Aviation Limited note recommendation AIC 21-R04/20-2003 and provide a response to the AIC within 90 days, but no later than 29/09/2021, and explain including with evidence how Hevilift (PNG) Aviation Limited has addressed the safety deficiency identified in Safety Recommendation AIC 21-R04/20-2003.

Hevilift (PNG) Aviation Limited response

Hevilift (PNG) Aviation Limited has accepted the Safety Recommendation and is conducting a process review of its Document Control Manual to ensure that operational documentation is updated in a timely manner and effectively disseminated throughout the company.

Hevilift (PNG) Aviation Limited plan to fully address the Safety Deficiency by the end of September 2021.

General Details

Date and time	18 October 2020, 08:54 local time (22:54 UTC)		
Occurrence category	Serious Incident		
Primary occurrence category	Fire or smoke – Non impact (F-NI) System/component failure or malfunction – Non Powerplant (SCF-NP)		
Location	Mount Hagen Airport, AYMH		
	Latitude	05°49' 40.1"S	
	Longitude	144°17' 58.3"E	
Elevation	5,386 ft		
Runways	1. 12 - 30 / 120° - 300°	Length: 2,190 m	Width: 30 m
	2. 08 - 26 / 80° - 260°	Length: 1,097 m	Width: 18 m
RFFS Category	CAT 6		
Apron surface and strength	MAIN APN SEALED, PCN 30, GA APN SEALED MAX 5,700KG		

Type of Operation, Injury and damage details

Type of Operation	IFR, passenger flight	
Persons on board	Crew: 2	Passengers: 14
Injuries	Crew: Nil	Passengers: Nil
Damage	Nil	

Meteorological Information

WEATHER FORECAST – AYMH	
1. Source: PNG National Weather Services	
Forecast type	Terminal Aerodrome Forecast
Validity	06:00-18:00, 18 October 2020
Wind	Calm winds
Visibility	500 m, with Fog
ACTUAL WEATHER – AYMH	
1. Specified weather report	
Validity	08:30 and 09:00, 18 October 2020
Wind	Calm winds
Visibility	5,000 m with Fog
Cloud	Overcast at 1,000 ft
Station level pressure	1020 hPa
2. Pilot report	
Cloudy within Kagamuga Airport area; cloud base at about 6,000-6,100 ft AMSL.	

Crew details

Pilot in Command

Gender	Male
Age	51

Nationality	Dutch
Licence type	PNG CPL
Total hours	2,245 hours
Total hours in Command	854.5 hours
Total hours on type	1,081.3 hours
Total hours in Command on type	184.45 hours

First Officer

Gender	Male
Age	40
Nationality	Papua New Guinea
Licence type	PNG CPL
Total hours	1,171.4 hours
Total hours in Command	106.6 hours
Total hours on type	614.7 hours

Aircraft Details

Aircraft

Aircraft manufacturer		Viking Air Limited
Aircraft Model		DHC-6-400
Registration		P2-KSY
Serial number		875
Year of manufacture		2013
Certificate of Registration issued		25 July 2019
Certificate of Authorisation	Issued	6 June 2013
	Valid to	Non-terminating
Total hours since new		5,675.63 hours
Total cycles since new		7139

Engine 1

Engine manufacturer and model	Pratt & Whitney, PT6-34
Engine type	Turboprop
Serial number	PCE-RB0684
Total cycles since new	7139
Total time since new	5,675.63 hours

Engine 2

Engine manufacturer and model	Pratt & Whitney, PT6-34
Engine type	Turboprop
Serial number	PCE-RB0685
Total cycles since new	7,139
Total time since new	5,675.63 hours

Propeller 1

Manufacturer	Hartzell Propeller Inc
Model	HC-B3TN-3D/T10282N
Serial Number	BUA28757
Time Since New	9,346.77 hours
Time Since Overhaul	2,251.97 hours

Propeller 2

Manufacturer	Hartzell Propeller Inc
Model	HC-B3TN-3D/T10282N
Serial Number	BUA21939
Time Since New	5,415.36 hours
Time Since Overhaul	2,620.36 hours

Hydraulic Pump

Manufacturer	Texas Air Services Inc.
Model	Dickinson, TX 77539
Part Number	C6NF2264-1
Serial Number	0182

Relay

Manufacturer	Leach International
Part Number	MS24166D-1

Appendices

Appendix A: Manufacturer's Technical diagrams of the Hydraulic System.

Appendix A-1: Hydraulic System Schematic

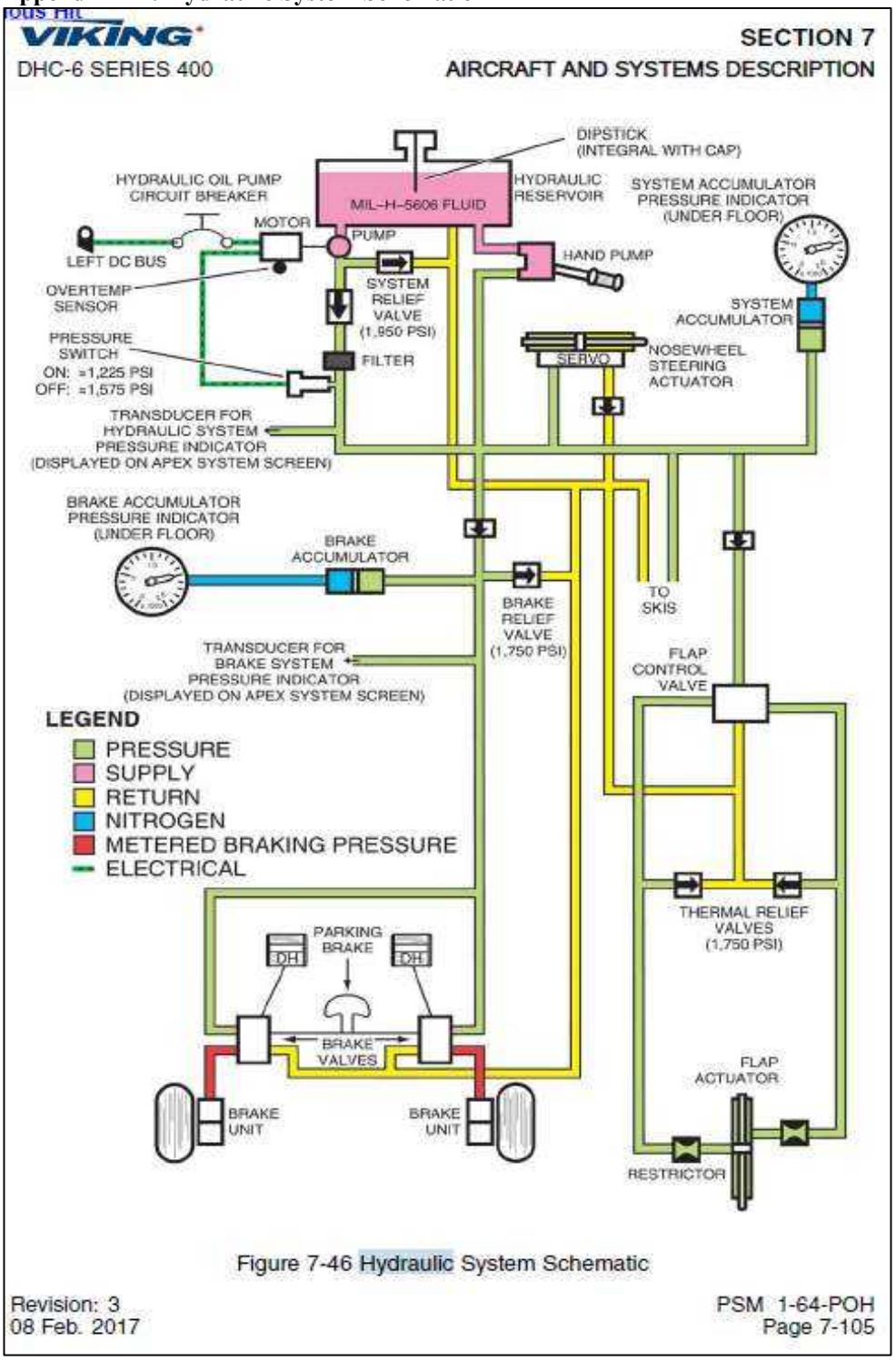

Figure 7-46 Hydraulic System Schematic

Revision: 3
08 Feb. 2017

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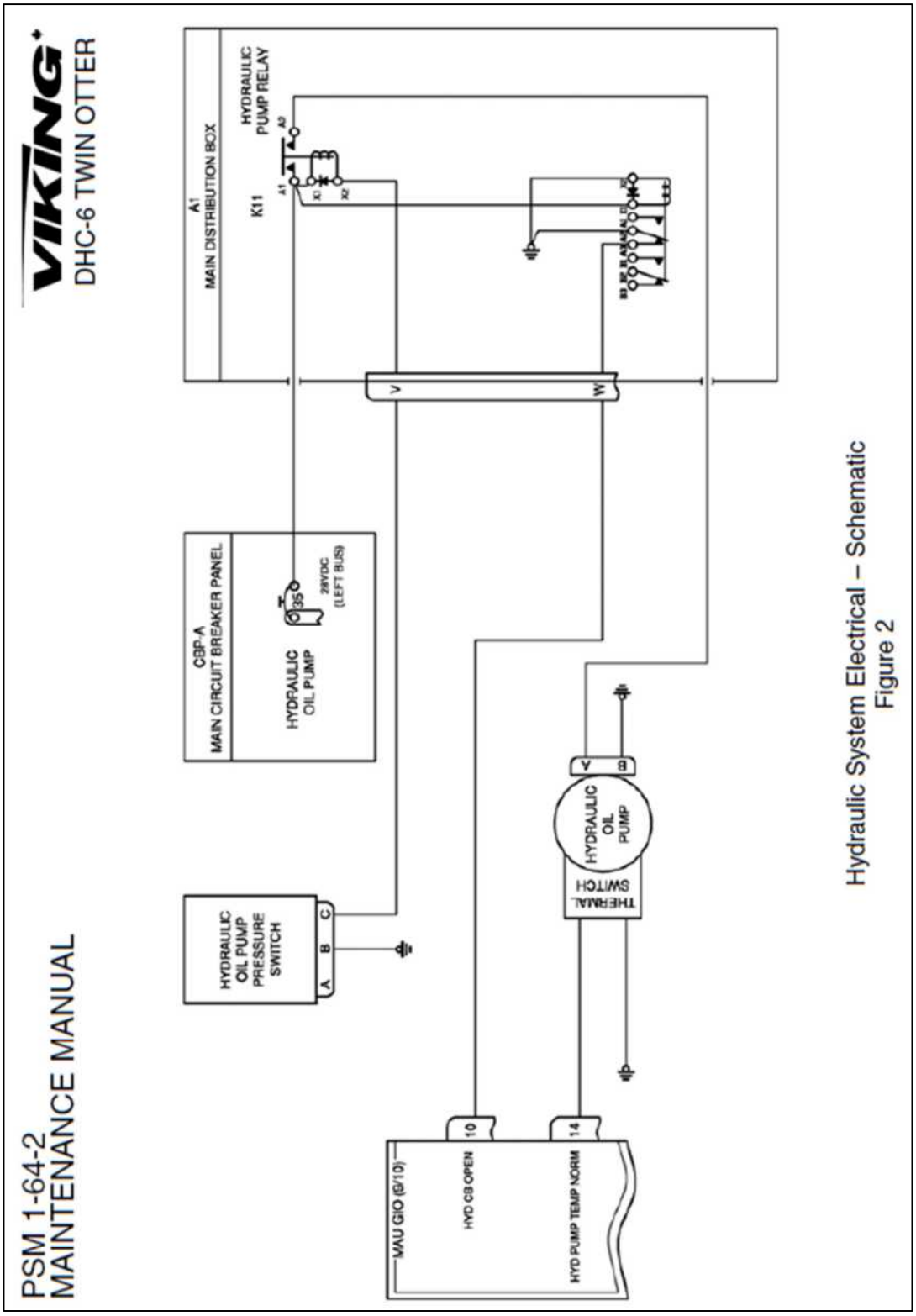
Appendix A-2: Hydraulic System Electrical Schematic



Appendix B: Viking Technical Bulletin TBV6/00031

VIKING

1959 de Havilland Way
Sidney, B.C.
Canada V8L 5V5
Tel.: (250) 656-7227

DHC-6
Twin Otter

TECHNICAL BULLETIN

ATA SYSTEM: 29-00 Number: TBV6/00031

SUBJECT: HYDRAULIC PUMP, THERMAL SWITCH WIRING REWORK.

I. PLANNING INFORMATION

A. Effectivity

Aircraft Affected: N/A.

B. Reason

To provide instructions for rework of AAT-600-029-100-1 Hydraulic Pumps to bring them in conformance with C6NF2264-1 Hydraulic Pumps. The pumps must be reworked prior to installation on the aircraft in order to properly interface with DHC-6-400 wiring.

C. Description

This Technical Bulletin provides instructions to perform the following tasks

1. Remove factory connectors from the Hydraulic Pump.
2. Install quick release splices and splice labels on wires.
3. Part mark the reworked Hydraulic Pump.

D. Approval

The technical content of this Technical Bulletin has been approved under the authority of the Transport Canada Civil Aviation (TCCA) Design Approval Organization (DAO) 04-V-02.

E. Manpower

The incorporation of this Technical Bulletin can be accomplished in approximately 2 hours.

F. Weight and Balance

Not affected.

G. Electrical Load Data

Not affected.

H. Publications Affected

None.

I. References

SNIEO C6HF1004-P-03

Note: This Technical Bulletin is self-contained. No drawings are supplied. For more information please contact:

Viking Air Limited
Technical Support
1959 de Havilland Way
Sidney, British Columbia
Canada, V8L 5V5
technical.support@vikingair.com

FAX: 250-656-0673
Telephone Numbers:
Regional: 250-656-7227
North America: 1-866-49-ATLAS
International: 1-800-6727-6727

II. ACCOMPLISHMENT INSTRUCTIONS

This Technical Bulletin is incorporated by accomplishing the rework of the AAT-600-029-100-1 Hydraulic Pump per the instructions detailed below.

1. Remove two factory connectors from the wires connected to the thermal switch, reference Figure 2.

2. Strip the insulation from wire ends to a depth of ¼" to expose bare connector. Use pneumatic or plier type strippers set to appropriate settings for the wire size. No broken wire strands are allowed, only 2 nicked wire strands are allowed.

   CAUTION: Do not use any type of manual, bare bladed cutting tool (e.g. Utility Knife) for stripping wire insulation under any circumstance.

3. Install splice identification labels onto the wires as follows,

   a. Ensure the area of wire over which the labels are to be applied is clean and free of grease or oil. If necessary, solvent clean using a clean cloth and isopropyl alcohol.

   b. Insert identification label (VSC1-C-SP176 or VSC1-C-SP177) onto each wire.

      Note: Label and wire combination is inconsequential.

   c. Shrink labels onto the wires using a Thermogun 500A hot air gun, or equivalent. Immediately after completion of shrinking, cease application of heat to prevent overheating.

4. Install quick disconnect splices (32446) onto wire ends and crimp using AMP 169400 crimper with 169404 attachment, or equivalent crimping tool (reference Figure 3).

5. Part mark reworked Hydraulic Pump as C6NF2264-1 using indelible ink.

Appendix C: Viking Operator Message DHC-6-AOM-29-001

VIKING

ALL OPERATORS MESSAGE DHC-6-AOM-29-001

TO: ALL OPERATORS OF DHC-6 SERIES 400 TWIN OTTER AIRCRAFT

ATTN: DIRECTOR/MANAGER OF: MAINTENANCE

FROM: VIKING AIR LIMITED

DATE: 08-MAR-2018

SUBJECT: HYDRAULIC SYSTEM PUMP/MOTOR OVER TEMP - AFM ABNORMAL PROCEDURE

PURPOSE:

This AOM highlights the use of an existing abnormal procedure in the AFM for the possible failure of the hydraulic pressure switch in the "ON" position resulting in a continuously running hydraulic pump motor and a subsequent, or impending, overheat of the hydraulic system pump/motor assembly.

BACKGROUND:

There have been reports of the hydraulic system pressure switch failing in the "ON" position resulting in a continuously running hydraulic pump/motor and a subsequent overheating of the hydraulic pump/motor assembly. Operators have reported burning fumes and/or smoke, often emanating from the hinged door of the emergency hand pump socket located in the cockpit floor. Further, indications of a continuously running hydraulic pump, causing a sustained hydraulic pressure of greater than 1575 psi have been observed on the hydraulic system pressure MFD display. The sustained hydraulic pressure above normal values is not in itself a hazard, but is an indication of a continuously running hydraulic pump/motor and the potential for pump/motor assembly overheat condition.

INTERIM DIRECTIVE

Operators are directed to disseminate this AOM to flight crews advising them of the indications and to highlight the existing procedures to be actioned in the event of an occurrence of this abnormal condition.

The recommended action is the HYDRAULIC PUMP OVER TEMP abnormal procedure from 3.16.2 of the AFM if:

1. **Smoke and/or fumes are observed in the cockpit, and a simultaneous sustained system hydraulic pressure of greater than 1575 psi is observed; or**
2. **If a sustained system hydraulic pressure of greater than 1575 PSI is observed.**

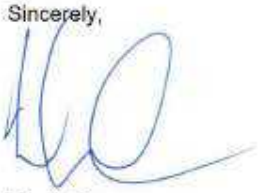
ALL OPERATORS MESSAGE DHC-6-AOM-29-001

INFORMATION:

Operators are directed to advise Viking Air Technical Support of past and future occurrences of this fault. For further information or to provide feedback on this matter, please contact our Technical Support help desk at:

Email : technical.support@vikingair.com
Fax : +1(250)-656-0673
Phone: +1(250)-656-7227
Toll Free: 1-800-663-8444 International Toll Free: +1-800-6727-6727

Sincerely,



Martin Swan
Vice President, Engineering

Appendix D: Viking Air Limited and Hevilift (PNG) Aviation Limited AFM – Hydraulic System Abnormalities, *Section 3.16.2 Hydraulic Pump Over Temp*

3.16.2 Hydraulic Pump Over Temp

INDICATION

Display of HYD PUMP OVER TEMP caution level (amber) CAS message.

PROBABLE CAUSE

Electric hydraulic pump has overheated.

ACTION

IF ON GROUND:

1 Stop aircraft and apply parking brake.

2 Pull HYDRAULIC OIL PUMP circuit breaker (position C6).

3 Use hydraulic hand pump to pressurize system.

4 Taxi with caution, maintaining hydraulic pressure with hand pump.

5 Repair before flight.

IF IN FLIGHT:

⚠ WARNING

DO NOT LAND AIRCRAFT UNTIL THE FOLLOWING CHECKLIST IS COMPLETED.

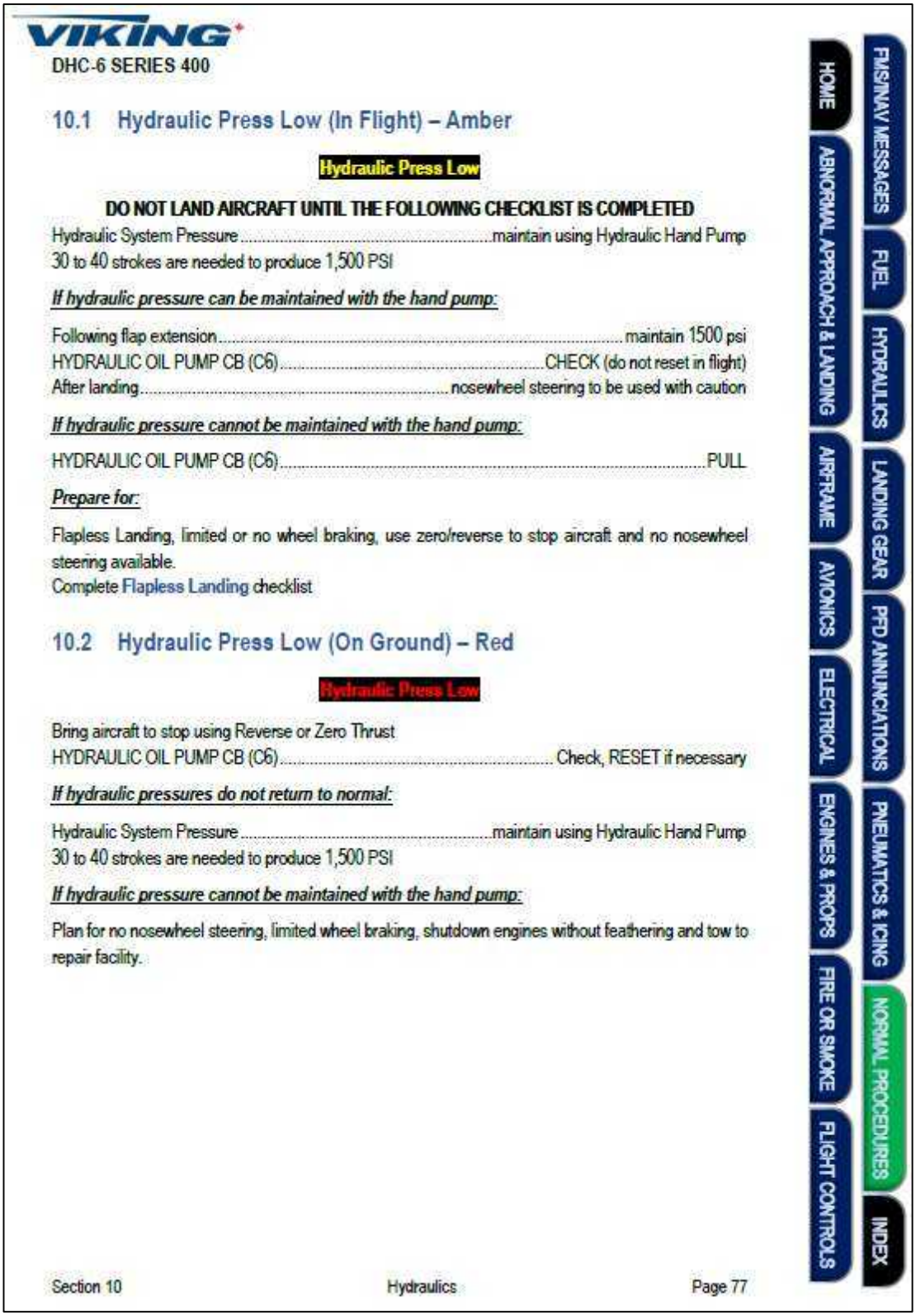
1 Pull HYDRAULIC OIL PUMP circuit breaker (position C6).

2 Use hydraulic hand pump to pressurize system.

3 Ensure that hydraulic system pressure is maintained at or above 1,500 PSI at all times following flap extension. After landing, nose wheel steering should be used with caution. Large movements of the nose wheel steering tiller may deplete the hydraulic system pressure faster than the pilot can operate the pump.

4 After landing, taxi with caution, maintaining hydraulic pressure with hand pump.

Appendix E: Viking DHC-6-400 QRH – Hydraulic System Abnormalities



VIKING
DHC-6 SERIES 400

HOME | ABNORMAL APPROACH & LANDING | AIRFRAME | AVIONICS | ELECTRICAL | ENGINES & PROPS | FIRE OR SMOKE | FLIGHT CONTROLS | FMS/NAV MESSAGES | FUEL | HYDRAULICS | LANDING GEAR | PFD ANNUNCIATIONS | PNEUMATICS & ICING | NORMAL PROCEDURES | INDEX

10.1 Hydraulic Press Low (In Flight) – Amber

Hydraulic Press Low

DO NOT LAND AIRCRAFT UNTIL THE FOLLOWING CHECKLIST IS COMPLETED

Hydraulic System Pressure ..... maintain using Hydraulic Hand Pump
30 to 40 strokes are needed to produce 1,500 PSI

If hydraulic pressure can be maintained with the hand pump:

Following flap extension ..... maintain 1500 psi
HYDRAULIC OIL PUMP CB (C6) ..... CHECK (do not reset in flight)
After landing ..... nosewheel steering to be used with caution

If hydraulic pressure cannot be maintained with the hand pump:

HYDRAULIC OIL PUMP CB (C6) ..... PULL

Prepare for:

Flapless Landing, limited or no wheel braking, use zero/reverse to stop aircraft and no nosewheel steering available.
Complete Flapless Landing checklist

10.2 Hydraulic Press Low (On Ground) – Red

Hydraulic Press Low

Bring aircraft to stop using Reverse or Zero Thrust
HYDRAULIC OIL PUMP CB (C6) ..... Check, RESET if necessary

If hydraulic pressures do not return to normal:

Hydraulic System Pressure ..... maintain using Hydraulic Hand Pump
30 to 40 strokes are needed to produce 1,500 PSI

If hydraulic pressure cannot be maintained with the hand pump:

Plan for no nosewheel steering, limited wheel braking, shutdown engines without feathering and tow to repair facility.

Section 10 Hydraulics Page 77

10.3 Hydraulic Pump Over Temp

Hyd Pump Over Temp

On ground:

Aircraft ..... Stop and apply parking brake
HYDRAULIC OIL PUMP CB (C6) ..... PULL OUT
Hydraulic Hand Pump ..... Maintain 1,500 psi
Taxi with caution. Repair before flight.

In flight:

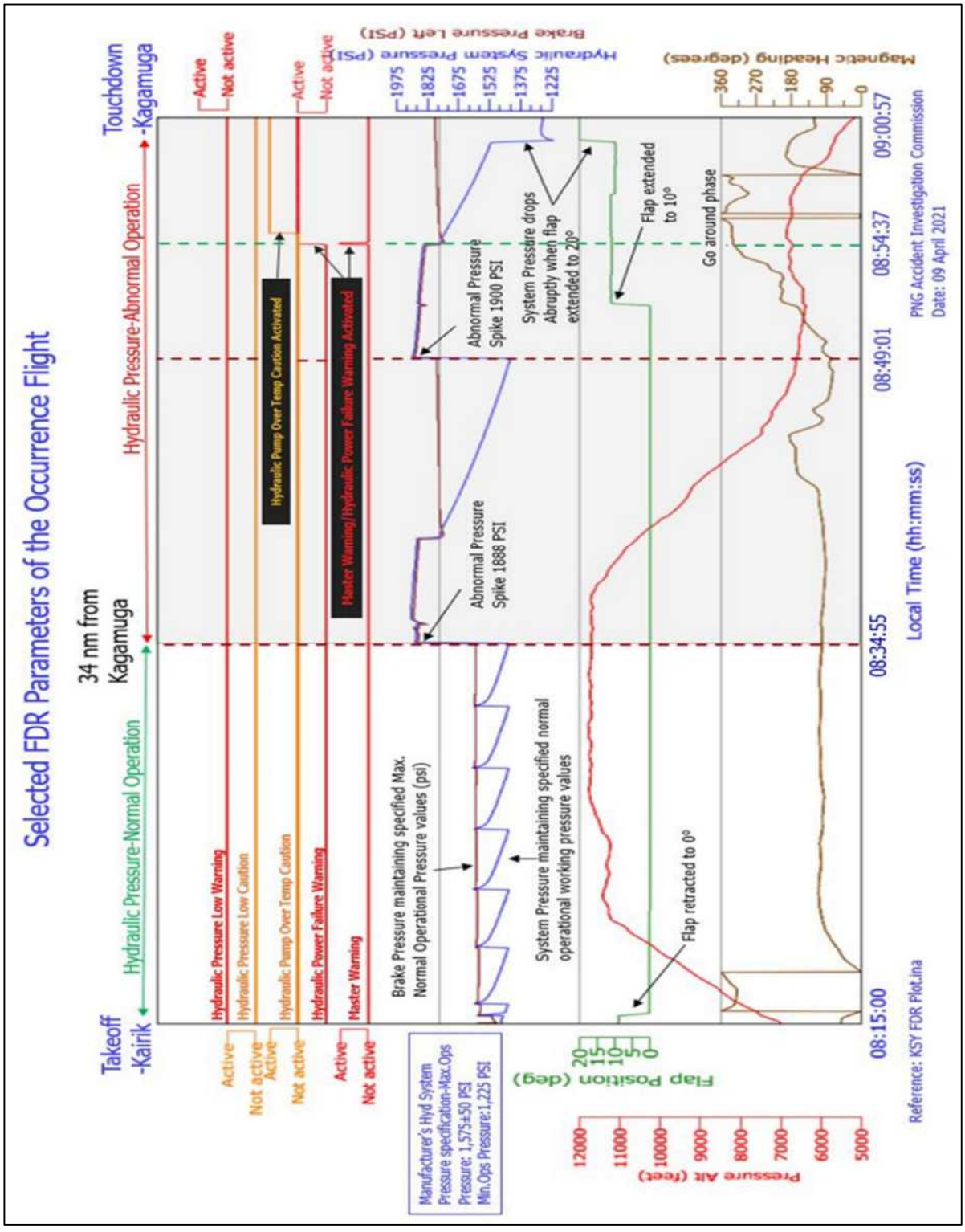
HYDRAULIC OIL PUMP CB (C6) ..... PULL OUT
Complete ..... Hydraulic Pressure Low (In Flight) - Amber

10.4 Hydraulic Power Fail

Hydraulic Power Fail

HYDRAULIC OIL PUMP CB (C6) ..... Check, RESET if appropriate
Hydraulic pump handle ..... maintain 1500 psi if necessary

Appendix F: FDR Recorded parameters of the occurrence flight from take-off to touchdown.



Appendix G: FDR Recorded parameters of the occurrence flight from touchdown to complete stop.