AIRCRAFT ACCIDENT REPORT

Cessna 208B Caravan

Registration – 8R-GHS

Near to Olive Creek Airstrip Region No. 7 Guyana

N06 10 09.9 W060 09 03.42

18th January, 2014

REPORT # GCAA: 2/5/1/73

This report represents the conclusions reached by the Guyana Civil Aviation Authority Accident Investigation Team on the circumstances surrounding the aircraft accident, involving Guyana registered aircraft – Cessna 208, 8R-GHS in which two persons died.

This investigation was done in accordance with Annex 13 to the Convention on International Civil Aviation. The investigation is intended neither to apportion blame, nor to assess individual or collective liability. Its sole objective is to draw lessons from the occurrence which may help to prevent future accidents.

Consequently, the use of this report for any purpose other than for the prevention of future accidents could lead to erroneous conclusions.

Contents

SYNOPSIS

On 18th January, 2014 Trans Guyana Airways Flight, TGA 700, a Cessna 208B, Registration No. 8R-GHS, departed Olive Creek Airstrip (SYOC) at approximately 14:54hrs UTC for Imbaimadai Airstrip (SYIB). One flight crew and a loader were on board the aircraft. The aircraft crashed approximately two and one-half minutes after takeoff, 3km south of Olive Creek, 06 10N, 060 09W. Both persons on board the aircraft died in the crash.

The accident was notified to:-

The State of Manufacturer	-	Federal Aviation Administration, USA
	-	National Transportation Safety Board, USA
Manufacturer	-	Cessna Aircraft Company, Wichita, Kansas, USA.
State of Engine Manufacturer	-	Transport Safety Board, Canada
Engine Manufacturer	-	Pratt & Whitney Canada Corp. Canada
Other Agencies	-	International Civil Aviation Organization
	-	Caribbean Aviation Safety and Security Oversight System

Guyana is both the State of Occurrence and the State of the Operator and is the Accident Investigation Authority. Non-travelling accredited representatives were nominated by the TSB of Canada and the NTSB, USA. Oversight of required examinations, to be done in Canada and the USA, will be supervised by TSB and NTSB representatives respectively, on behalf of the Guyana Civil Aviation Authority.

ABBREVIATIONS

ADAS -	Aircraft Data Acquisition System
AMEL -	Aircraft Maintenance Engineer Licence
AMO-	Approved Maintenance Organization
ATC –	Air Traffic Control
ATCO -	Air Traffic Control Officer
ATS –	Air Traffic Services
°C –	Degrees Centigrade
CAMS -	Caribbean Aviation Maintenance Services
CASSOS –	Caribbean Aviation Safety and Security Oversight System
CJIA –	Cheddi Jagan International Airport
CMA -	Continuous Monitoring Approach
DG -	Dangerous Goods
ELT –	Emergency Locator Transmitter
EPL –	Emergency Power Lever
ETMS –	Engine Trend Monitoring System
°F –	Degrees Fahrenheit
FAA –	Federal Aviation Administration (United States of America)
FOM -	Flight Operations Manual
FPM –	feet per minute
Ft-lbs –	Foot-pounds
G -	Gravitational/g-force
GCAA –	Guyana Civil Aviation Authority
GDF –	Guyana Defence Force
GPF -	Guyana Police Force
GPS –	Global Positioning System
HF –	High Frequency
IAW –	In Accordance With
ICAO –	International Civil Aviation Organization
ID -	Identification

IFR – Instrument Flight Rules

IR – Instrument Rated

ITT - Inter-turbine Temperature

Km - Kilometers

LWTR – Licence Without Type Rating

m – meters

max – maximum

Mb – Millibars

MEL – Minimum Equipment List

Min – minimum

MPM - Maintenance Procedures Manual

NAV - Navigation

Ng - Gas generator speed

No. - Number

Np - Propeller Speed

NTSB – National Transportation Safety Board (United States)

OAT - Outside Air Temperature

OEM - Original Equipment Manufacturer

OJT - On the Job Training

OSC - On-scene Commander

PIC – Pilot in Command

P/N – Part Number

POH - Pilot's Operating Handbook

PW&C - Pratt and Whitney Canada

RCC - Rescue Coordination Center

RF - Radio Frequency

RPM – Revolutions per minute

SAR - Search and Rescue

SHP - Shaft Horse Power

SI - Special Instruction

SMC - SAR Mission Coordinator

S/N – Serial Number

SOPs – Standard Operating Procedures

SRU - Search and Rescue Unit

STC - Supplemental Type Certificate

SYGO - Ogle International Airport (ICAO 4-letter code)

SYIB - Imbaimadai Airstrip

SYOC - Olive Creek Airstrip

TGAL - Trans Guyana Airways Limited

Tq - Torque

TSB - Transportation Safety Board (Canada)

USMCC - United States Mission Control Center

UTC – Coordinated Universal Time

VFR – Visual Flight Rules

VHF – Very High Frequency

W_f - Fuel Flow

1. FACTUAL INFORMATION

1.1. History of the Flight

On 17th January, 2014, the day before the accident, the pilot departed from his company base, Ogle International Airport (SYGO) with another aircraft, a Cessna 208B, Registration – 8R-GHT. He was tasked to do two days of shuttling; the first day between Olive Creek and Ekereku Bottom Airstrips, and the second day between Olive Creek and Imbaimadai Airstrips. The pilot was accompanied by a third crew/loader, whose duty was to ensure that the aircraft was properly loaded for each trip, and an aircraft engineer who was assigned to carry out minor maintenance duties and refuel the aircraft as required for the duration of the shuttle operations.

It was reported that on the first day, during a landing at Ekereku Bottom, the aircraft encountered severe wind conditions that resulted in a hard landing. The pilot was very concerned about the hard landing and expressed this to several individuals. He was concerned enough to log the hard landing in the Aircraft Technical Log. After the hard landing the aircraft was visually inspected by the engineer who declared the aircraft fit for flight. However while taxying prior to takeoff the aircraft suffered a right brake seizure. The engineer freed and bled the brake line. Tests were done on the brakes and the aircraft was flown to Olive Creek. The hard landing and the brake failure were reported to base and an instruction was passed that this aircraft should be brought back to Ogle by another pilot. Another Cessna 208B aircraft, 8R-GHS, the accident aircraft, was left with the pilot for him to complete his shuttle schedule the next day.

On the afternoon of the first day, the pilot flew this aircraft, 8R-GHS to Kamarang Airstrip, where he overnighted. On the second day, 18th January, 2014, he departed Kamarang at 10:30hrs UTC for Olive Creek with the engineer and the loader. The engineer was left at Olive Creek. The pilot, with the loader, did one shuttle from Olive Creek to Imbaimadai. He returned to Olive Creek where the aircraft was refueled and then did three shuttles between Olive Creek and Imbaimadai. After these three shuttles the aircraft was again refueled. He completed one shuttle, Olive Creek/Imbaimadai/Olive Creek and had just taken off on the

second in this series of shuttles when the accident occurred during midmorning. Both the pilot and the third crew were killed in the crash.

1.2. Injuries to Persons

Table:1- Showing Injuries to Persons

Injury	Crew	Passengers	Others	Total
Fatal	1	1	0	**2**
Serious	0	0	0	**0**
Minor/None	0	0	0	**0**
Total	**1**	**1**	**0**	**2**

1.3. Damage to Aircraft

The entire aircraft suffered catastrophic damage. It impacted several sturdy trees before coming to a stop. Most of the aircraft parts remained attached to the fuselage. The fuselage was offset left of its longitudinal axis with the right side twisted upwards. The left wing of the aircraft was broken off and was lying next to the fuselage. The right wing was folded over as if it were the left wing. The empennage was severely damaged. Two of the propeller blades had penetrated the ground. The other two showed signs of impact with trees and the ground. The left side of the engine cowl was penetrated by a broken tree trunk, which punctured the engine in the vicinity of the combustion casing.

1.4. Other Damage

The aircraft cut a swathe where it went through the trees. The area where the aircraft came to rest was ploughed up.

1.5. Personnel Information

1.5.1. Flight Crew

Pilot Licence	Guyana Commercial Pilot Licence #290
Aircraft Ratings	Single Engine Land; Multi Engine Land
Type Ratings	BN2 Islander; Cessna 208B
Date of Birth	22nd May, 1988
Age	25 years
Type of Medical	1st Class
Medical Expiry Date	31st March, 2014
Total Flying Hours	3108:00hrs
Hours on Type	2555.00hrs
Duty in Last 7 days	24.43hrs
Duty in last 24 hours	5.03hrs
Last Proficiency Check (APC/IPC)	29th November, 2013

The pilot was an employee of Trans Guyana Airways Ltd (TGAL), having joined the company in April 2011. He completed his last medical on 13th September, 2013. The limitation on the medical indicated that he needed to wear corrective lenses. The record of his flight and duty times up to 17th January, 2014 was within acceptable limits. Training records indicate that the Captain had received the standard company training for the aircraft type. This included ground, simulator and flight training. The pilot also completed the regularly scheduled Proficiency Checks, which are standard regulatory and company requirements.

1.6. Aircraft Information

1.6.1. General

Manufacturer	Cessna Aircraft Company
Aircraft Registration	8R-GHS
Type and Model	Cessna 208B – Grand Caravan
Year of Manufacture	1990

Serial Number	C208B 0830
Certificate of Airworthiness	Valid to 15th January, 2015
Total Airframe Time	17,998:22hrs
Next Inspection	Mini Check - Due at 18,038:57Hrs
No. and Type of Engine	One – PWC PT6A-42A, 850 SHP
Engine Serial Number	PCE PM 0580
Total Engine Time	879:12hrs
Maximum Allowable Take Off Weight	9,062lbs
Maximum Allowable Landing Weight	9,000lbs
Fuel Type	Av Jet

1.6.2. Maintenance

Examination of the aircraft maintenance records indicate that there were no outstanding maintenance issues. All required and scheduled maintenance had been performed and all Airworthiness Directives had been complied with.

There were no outstanding MEL items on the aircraft. Total airframe time on the aircraft prior to the accident was 17,998.22hrs.Total engine time was 879:12hrs. The next inspection is a mini check due in 40:37hrs.

1.6.3. Mass and Balance

The aircraft was dispatched with a payload of seven drums of diesel weighing 2835lbs. This was a standard weight used by the company.

The company's Flight Operations Manual (FOM) requires that a properly completed load sheet must be prepared and presented to the pilot for his signature, for every flight. No load sheet was prepared for this flight.

1.6.4. Cargo Area

For this flight, the aircraft was being operated in full cargo mode, but an additional seat was installed immediately behind the pilot's seat and was occupied by the loader.

A plywood floor board was installed on which seven 45 gallon drums of diesel were placed. These drums were loaded on the starboard side of the passenger compartment. The first two

drums were placed in a lying position, behind the right No.1 passenger/co-pilot seat; the next four were stood upright bracing the first two; and the seventh drum was placed lying behind and bracing the upright drums. Two heavy duty straps with spring type hooks and ratchets crisscrossed the three drums that were lying flat. The hooks were attached to tie down attach points in the floor of the aircraft and the straps were ratcheted to tighten them around the drums. Apart from being braced by the drums that were lying flat, there were no restraints to the four drums that were standing upright. No other safety devices, such as a cargo barrier or cargo restraint net, which could have prevented movement of the cargo were in use for this flight.

1.6.5. Crew and Passenger Entry/Exits.

Doors are located on each side of the cabin at the pilot's and front passenger's position. Either of these doors can be used for crew entry/exit. A two piece air-stair type door is located on the right side of the aircraft, behind the wing for passenger entry/exit. The aircraft also has a cargo door, on the left side just behind the wing, which can also be used for entry/exit.

The aircraft also has sixteen fixed cabin side windows, including one each in the two crew entry doors two in the upper section of the cargo door and one in the upper section of the passenger entry door.

1.6.6. The Engine

The aircraft is powered by one P&WC PT6A-42A engine rated 850 shaft horse power (SHP) at 2000RPM propeller speed. This engine is a standard PT6A-42 that is installed in several other types of aircraft, with modifications for single engine installation. However, installation of this engine is a Blackhawk modification to the Cessna Caravan aircraft, which is normally powered by the PW&C PT6A-114A engine. The modification to the aircraft includes a factory new P&W PT6A-42A engine and a new wide chord, 100 inch diameter Hartzell four blade propeller, new composite cowling and higher efficiency inlet duct, new 40% larger oil cooler, new Blackhawk DigiLog engine gauges and new exhaust stacks. The modification was installed in accordance with STC SA02357LA. The engine was installed new from the factory on 26th June 2013 and had acquired a total of 879.5hrs. The engine was sent to the manufacturer, Pratt and Whitney Canada for analysis.

1.6.7. Engine Controls

The engine controls for the PT6A-42A engine are the same as for the standard engine. The engine is operated by four separate controls. These are the power lever, the emergency power lever (EPL), the propeller control lever and the fuel condition lever.

The power lever controls engine power, ranging from maximum takeoff power through idle to full reverse. It also selects propeller pitch in the BETA range which consists of power lever positions from flight idle to maximum reverse.

The EPL is connected to the manual override lever on the fuel control unit and governs fuel supply to the engine, if a pneumatic malfunction occurs in the fuel control unit. The EPL allows the pilot to restore power in event of such a failure. The EPL positions are NORMAL, IDLE and MAX. The NORMAL position is used when the fuel control position is functioning normally and engine power is selected by the power lever. The range from IDLE to MAX is used when a malfunction has occurred in the fuel control unit and the power lever is ineffective. The EPL is positioned in a mechanical stop slot that requires the EPL to be moved to the left to clear the stop before it can be moved from the NORMAL position to the IDLE position. Service Kit SK208-142 which requires installation of a copper witness wire to indicate when the EPL has been moved from the NORMAL position was incorporated in this aircraft. If it becomes necessary to move the EPL the copper wire breaks easily with movement of the lever.

The propeller control lever is linked to the propeller governor and controls the propeller governor settings from maximum RPM position to full feather. The lever has MAX, MIN and FEATHER positions. The MAX position is used when high RPM is desired and governs the propeller sped at 2000RPM. Lever settings from MAX to MIN allows the pilot to select the desired engine RPM for cruise. The FEATHER position is used during normal engine shutdown and to feather the propeller.

The fuel condition lever is linked to a combined lever and stop mechanism on the fuel control unit. The lever and stop also function as an idle stop for the fuel control unit rod. The fuel condition lever controls the minimum RPM of the gas generator turbine (Ng) when the power lever is in the IDLE position. The fuel condition lever positions are CUTOFF,

LOW IDLE and HIGH IDLE. In the CUTOFF position, the fuel condition lever shuts off all fuel to the engine fuel nozzles.

In addition to the above mentioned controls, the aircraft is also equipped with a quadrant friction lock, which is located on the right side of the pedestal and helps to minimize creeping of the engine controls once they have been set. The lock is a knurled knob that increases friction on the engine controls when rotated clockwise.

1.6.8. Engine Instruments

Engine operation is monitored by the following instruments; torque indicator, propeller RPM indicator, Inter-turbine Temperature indicator (ITT), Ng% RPM indicator, oil pressure gauge and oil temperature gauge. All of these instruments are located on the upper portion of the instrument panel.

The torque indicator shows the torque being produced by the engine. It is pressure actuated. Two independent lines, one measuring the engine torque pressure and the other measuring the gearbox internal pressure, enter the back of the torque indicator. The torque indicator monitors the engine torque pressure and converts this into an indication of torque in foot-pounds.

The propeller RPM indicator is marked in increments of 50 RPM and indicates propeller speed in RPM. It is electrically operated from the propeller tachometer-generator.

The ITT indicator displays the gas temperature between the compressor and power turbines.

The Ng% RPM indicator indicates the percent of gas generator RPM and is electrically operated from the gas generator tachometer-generator.

The oil pressure gauge and the oil temperature gauge are the left half and the right half respectively of a dual-indicating instrument. A direct pressure oil line from the engine delivers oil at engine operating pressure to the oil pressure gauge. The oil temperature gauge is operated by an electrical-resistance type temperature sensor which receives power from the aircraft's electrical system.

The fuel flow indicator shows the fuel consumption of the engine in pounds per hour, based on Jet A fuel. It is powered by a pull-off type circuit breaker. Fuel quantity is measured by eight fuel quantity transmitters, four in each tank. The fuel is measured by volume in pounds, based on the weight of Jet A fuel on a standard day, and gallons. The fuel quantity indicators shows an empty tank by a red line and the letter E. This indicates that approximately 2.8 gallons of unusable fuel remains in the tanks.

1.6.9. Engine Fuel System

The aircraft fuel system consists of two vented integral fuel tanks with shut off valves. A fuel selectors-off warning system, a fuel reservoir, an ejector fuel pump, an electric auxiliary boost pump, a reservoir manifold assembly, a firewall shut off valve, a fuel filter, an oil-to-fuel heater, an engine driven fuel pump, a fuel control unit, a flow divider, dual manifolds and fourteen fuel nozzle assemblies. A fuel can and drain is also provided.

The fuel system provides fuel flow to satisfy the speed and power demands of the engine. The pump increases the fuel pressure and sends it to the fuel control unit via a 10-micron filter in the pump outlet. By controlling the speed of the compressor turbine, the fuel control unit determines the proper fuel schedule to provide the power required, as established by the power lever input. The temperature compensating section alters the acceleration fuel schedule to compensate for fuel density differences at different fuel temperatures, especially during fuel start. The power turbine governor which is located in the propeller governor housing, provides turbine over-speed protection in the event of propeller governor failure, by limiting fuel to the gas generator. During reverse thrust, maximum power turbine speed is controlled by the power turbine governor.

1.6.10. Engine Trend Monitoring System (ETMS)

The ETMS monitors and records engine measurements from the electronic engine instruments and records date, time, OAT, airspeed, altitude and the EPL position. The captured data is analyzed regularly to assess engine operation and performance to predict and schedule required engine maintenance. Performance of the ETMS is indicated by the trend button, which, by displays of steady or flashing green, yellow or red lights indicate changes in the status of the engine. The ETMS automatically starts recording upon engine start, engine operational exceedance or a system fault. Automatically recorded data is stored

for future export. Data can be recorded manually at any time while the unit is powered up. To store manually recorded data, the trend button must be pushed.

The ETMS that was installed in the aircraft is the Aircraft Data Acquisition System (ADAS).

1.6.11. Flaps

Flaps are mounted on the trailing edges of the aircraft wings and are devices used to improve the lift characteristics of the wing. On the Cessna 208, the flaps include a trailing edge angle and leading edge vortex generators which are used to reduce stall speed and provide enhanced lateral stability.

Flaps are electrically driven with settings of 10°, 20° and 30°. A 20° flap setting is recommended for normal takeoff. It allows for lower takeoff speeds and reduction in ground roll and total distance over an obstacle.

1.6.12. Propeller

The propeller is a Hartzell 4-blade 100 inch aluminum propeller. It is a constant speed, full feathering, reversible, hydraulic actuated, wide chord propeller.

1.6.13. Emergency Locator Transmitter (ELT)

The aircraft was equipped with an ARTEX G406-4 ELT and a NAV to ELT interface. This ELT was installed IAW modification MR/002/04/08. It transmits on 121.5MHz, 243MHz and 406.025MHz simultaneously using two separate antennas. The ELT automatically activates during a crash and transmits the standard tone on 121.5MHz and 243MHz. The 406.025MHz comes on every fifty seconds and transmits an encoded digital message to a satellite. The message includes the Serial Number of the transmitter or the aircraft ID; the country code; ID Code and the position coordinates. The 406.025MHz operates up to twenty-four hours and then automatically shuts down. The 121.5/243MHz unit continues to operate until its battery life is exhausted, which is typically seventy-two hours.

The G406-4 ELT is simple to operate. It is designed to activate in a crash as long as it is locked into its mounting tray. It is also protected against human error and misuse with

regard to automatic activation. It also cannot be activated by dropping, rough handling or during shipping.

The ELT that was installed in this aircraft was not activated in the crash. It was been sent to the NTSB for analysis.

1.6.14. The Spot Tracker

A portable Spot Tracker was on board the aircraft. It is a device that uses satellite facility to provide real time location tracking via the internet, using Google Earth. While the Spot Tracker is not an aviation approved device and is not a substitute for a full-fledged Emergency Locator Beacon, it nevertheless, has several features that make it advantageous for use by pilots operating in Guyana. It also allows the aircraft owner/operator to keep track of their aircraft around the clock by monitoring on a computer or smart phone. The information displayed, facilitates real time tracking and can be stored for future reference. It also saves location/way points that allow one to retrace the progress of a previous trip.

1.7. METEOROLOGICAL INFORMATION

This accident occurred in daylight. There is no weather observation or recording station in the vicinity of the departure aerodrome or the accident site. The engineer who was responsible for minor maintenance and refueling the aircraft indicated that the weather was fair. However, the aircraft made a slight deviation shortly after takeoff and he thought that it might have been to avoid weather.

Another pilot who was operating in the vicinity of the accident flight reported that at the time of the accident the “cloud base was 2500ft with haze, visibility in excess of three miles”.

The aircraft is equipped with the RDS-81 color Weather Radar System, which is designed to detect significant en-route weather up to 190nm away.

1.8. Aids to Navigation

There are no aids to navigation in the area.

1.9. Communications

The frequencies available for communications between the FIC and aircraft are; 124.2MHz, 130.125MHz and 6735.5KHz.There were no reported malfunctions of the aircraft or FIC communications systems at the time.

Company policy dictates that the PIC of every flight is required to transmit flight plans and other significant information to the company's radio room. Where communication is not possible the PIC is required to broadcast 'blind' in expectation that other aircraft in the vicinity will relay the information to ATC.

A pilot reported that he heard the accident pilot broadcasting a traffic advisory indicating that he was going into position at Olive Creek for takeoff. He did not hear a takeoff call. The next call he heard was the May Day. Both the traffic advisory and the May Day call were made on 124.2MHz. The Georgetown Flight Information Center (FIC) did not hear the calls from the accident aircraft, but the pilot who heard those calls was able to relay the information to the FIC on 124.2MHz.

1.10. Aerodrome Information

This was an off aerodrome accident that occurred about two and a half minutes after takeoff.

1.11. Flight Recorders

The aircraft is not required to be equipped with flight recorders.

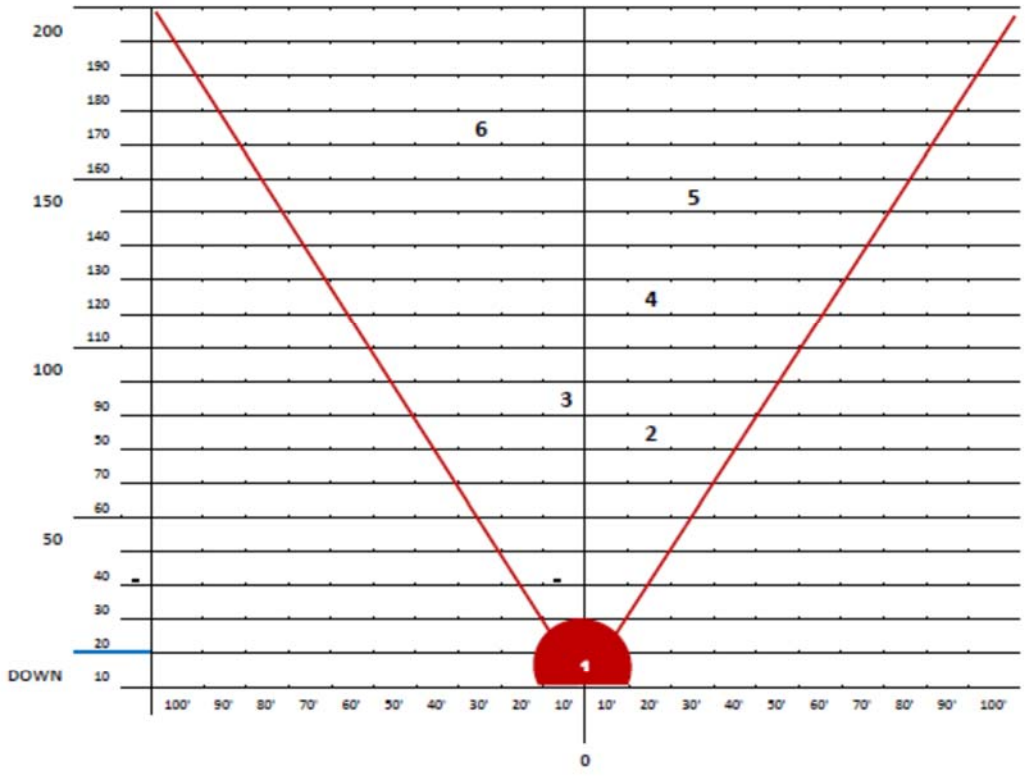
1.12. Wreckage Information

1.12.1. Wreckage site

The wreckage debris field was found over an area of approximately 180ft from the point of impact. The angle of penetration, from the point of impact to the wreckage, indicated an approximate slope of 30°. Pieces of the aircraft were found between 10° and 30° left of the penetration line and two pieces were found between 5° and 10° to the right.

The area was undulating and heavily forested, and initially was only accessible to Special Forces members of the military who had to clear and trek through dense jungle. A suitable site was found and cleared approximately 400ft from the wreckage to allow the helicopter to land. The bodies and parts of the wreckage had to be fetched from the wreckage to the helicopter for extraction.

Diagram:1 – SHOWING SCATTER OF AIRCRAFT WRECKAGE



1. A/C WRECKAGE
2. LEFT ELEVATOR
3. RIGHT WING RADOME
4. RIGHT FLAP
5. RIGHT WING
6. RIGHT AILERON

1.12.2. Damage to Aircraft

Most of the aircraft parts remained attached to the fuselage. There was severe damage to both wings and the empennage. The fuselage was offset to the left of its longitudinal axis with the right side upwards. Two of the propeller blades were partially buried in the ground and the other two showed signs of impacting trees and the ground.

The trunk of a broken tree had penetrated the left side of the engine cowl and punctured the engine in the vicinity of the combustion casing. When the engine cowling was opened the turbine casing showed impact distortion and engine frames were broken and bent.

The nose landing gear collapsed and was embedded in the ground beneath the engine. Both the port and starboard main gear wheels were forced backwards and upwards so that the wheels were almost in line with the fuselage.

The pilot's seat was deformed. The copilot seat was intact. The left No.1 passenger seat was displaced from the seat rails.

The instrument panel and the engine firewall were pushed back approximately one foot. The glare shield was separated from its fastenings.

Examination of the flying control cables showed no separation between attachment points.

The ELT antenna was ripped from its attachment.

1.13. Medical and Pathological Information

1.13.1. The Pilot

The post mortem was done by a forensic pathologist at the Georgetown Public Hospital mortuary on 22nd January, 2014.

The external examination showed injury to the right leg and foot and left arm. Internal examination showed injuries to the head, neck, brain, spine, lungs and heart. There was blood in the abdominal cavity and the kidneys were damaged. There was a closed fracture of the right pelvic. There was evidence of multiple blunt trauma to the body along with hypo extension of the neck and Broncho-aspiration. The cause of death was stated as multiple injuries.

1.13.2. The Third Crew/Loader

External examination showed injury to the right knee, leg and ankle. Internal examination showed injury to the head, brain, lungs, heart. There was massive bleeding in the chest and upper back. The breast bone, between the 4th and 5th ribs were fractured and the 3rd to 6th ribs on the right were fractured. There was evidence of crush injuries to the chest. It was

stated that death was caused by asphyxiation due to crush injuries to chest compounded by blunt trauma to the head.

1.14. Fire

There was no fire.

1.15. Survival Aspects

The first indication of a problem was a May Day call from the pilot. His call was heard by several other pilots who were on the frequency at the time. The only information he was able to provide was the North coordinate of his position. Because his takeoff time was not known, it was difficult to immediately determine the location of the crash site, as a result, the initial search area was away from the crash site. ATS were notified of the crash by one of the pilots who heard the May Day call. Both the FIC and other pilots made unsuccessful attempts to establish contact with the aircraft. Search and Rescue (SAR) was initiated immediately as several aircraft operating in the vicinity, diverted from their normal operations to search.

The Rescue Coordination Center (RCC) was immediately activated. Contact was made with the company's radio room which advised that the last report from the aircraft was that it had flown from Olive Creek and had landed at Imbaimadai Airstrip. This initially caused some confusion as neither the FIC nor the Company Radio Room was aware that the aircraft had flown from Imbaimadai to Olive Creek and was now flying from Olive Creek back to Imbaimadai. However, one of the pilots who heard the May Day call had also heard the accident pilot broadcasting that he was going into position for takeoff from Olive Creek to Imbaimadai. This was approximately seven minutes before the May Day call. He was therefore able to confirm that the accident flight was from Olive Creek to Imbaimadai.

The loader was seated behind the pilot. The cargo was loaded on the right side of the aircraft extending from behind the copilot's seat to just fore of the main exit. The cargo, of seven

drums of diesel, had shifted and was concentrated towards the front left of the aircraft. The loader was found beneath the cargo. The pilot was pinned between the cargo which had moved forward and the instrument panel that had moved backwards. Seat belts for both the pilot and the loader were intact but the loader's seat belt was unfastened.

Wreckage location was spotted one day after the crash and rescuers reached the wreckage the next day. Extraction of the bodies proved to be quite time consuming. This was not achieved until the fourth day.

1.16. Tests and Research

1.16.1. ADAS

The ADAS was sent to the manufacturer, the Trend Group, Camp System International, Connecticut, USA for analysis. The ADAS records engine measurements from the electronic engine instruments and date, time, OAT, airspeed, altitude and the EPL position. The Trend Group indicated that it has records on file of the trend monitoring graph and cruise data since the engine was installed. Based on the data, no maintenance recommendations were made to the operator since the installation. Data from the accident flight was downloaded and used to analyze the engine performance.

1.16.2. The Engine

The engine was returned to the manufacturer, P&WC for analysis under the supervision of the Transportation Safety Board (TSB) of Canada. The engine analysis report is Report No.: 14-004 dated 28 April 2014. A Supplementary Report, with one amendment, dated 13 May 2014 was subsequently issued. The change made by the Supplementary Report advised that PW&C would issue a Special Instruction, #SI-01-2013R3, as a containment action. This Supplementary Report was accompanied by the P&WC Special Instruction #SI-01-2013R3, which advised operators of the Caravan with Blackhawk conversion, to implement an in-situ boroscope inspection, at intervals, of the braze condition on the PT6A-42A First Stage Compressor Stator Assembly. PW&C has also started their escape management process to

determine the root cause of the lack of adhesion. A multidisciplinary team was created to review the supplier manufacturing process.

In a covering letter, that accompanied the Supplementary Report, dated May 13th 2014, sent to the CAMS Director of Maintenance, P&WC stated that since 2012, there were two cases of "airfoil liberation from the 1st stage compressor stator on PT6A-42A engines installed in a Cessna XP42A". In both of these cases it was found that the braze joint at the junction of the airfoil and stator ring had an area of weak adhesion. The letter also stated that P&WC has taken the initiative to institute a temporary requirement for stator braze inspections in the field, pending a revision that will require a braze process improvement that will increase the braze contact area and improve the bond strength. CAMS had no previous knowledge of this problem or of the temporary requirement for the field inspections.

1.16.3. The ELT

The ELT was dispatched to the NTSB for analysis. Inspection and tests were done on the ELT by ACR/ARTEX – ACR Electronics Inc. Examination showed that there was no physical damage to the ELT and all the connectors were locked in place. There was minor corrosion on two of the mounting pins, all other connections were in good condition. One corner of the mounting plate was bent. A piece of sheared metal was attached on the bent corner. The co-axial cables were cut but the wire harness was in good condition. One side of the ELT had several scratches which points to vibration in the mounting cradle. The ELT was in good condition, but was dirty, being covered with dust and ground particles.

The battery check activity showed that there were eleven activations with a total of 37.8hrs running time.

The Automatic ELT Tester showed that the ELT transmitted on all frequencies as per specifications. Measurement showed that transmission on 406MHz and 121.5MHz was normal at nominal power. Under the centrifuge test, the G-switch activated at 2.9Gs instead of within the activation window which is 2-2.6Gs.The unit passed the manual G-switch activation.

Inspection of the Nav interface showed that there were uniform scratches on the unit with minor corrosion on the cover plate. The connector was in good condition with all pins in

place. The seal gasket was in place, in good condition and all screws were in place and properly torqued. Tests showed that the unit performed in keeping with its original specification.

1.16.4. Propeller

The propeller teardown exercise was done in Guyana by the Air Safety Investigation Manager of Hartzell Propeller Inc.

The report showed that most of the connectors, between the propeller and the engine, and the components of the propeller were intact and unremarkable. The propeller blades had mild bending. There was no rotational scoring of the blades or twisting and tearing.

1.17. Organizational and Management Information

1.17.1. General

Trans Guyana Airways Limited (TGAL) is a member company of the M.C. Correia Holdings Group of Companies and is one of the oldest aircraft operators in Guyana. Initially aircraft operations started in the 1950's in support of the owner's mining and other operations in Guyana's hinterland. By the 1980s, TGAL came into being and eventually grew into a full-fledged commercial aircraft operator doing domestic and international, scheduled and charter operations. The company's main base is at Ogle International Airport. The location at Olive Creek is a hub for TGAL's aircraft operations.

1.17.2. Management Staff

The Accountable Manager is the owner of the company. He is considered to be very involved in his company's operations. From observation of the company facilities it is obvious that much time, effort and money has been invested in the organization.

Technical operations of the company are controlled by a Director of Flight Operations who reports to the Accountable Manager. He is responsible for the safe and efficient operations of TGAL and is required to ensure that operations meet standards acceptable to the GCAA. Among his listed duties he is responsible for ensuring that aircraft are adequately equipped

for safe and efficient flight operations. He also has overall responsibility for flight and ground training and engineering procedures.

The Chief Pilot reports to the Director of Operations and is responsible for ensuring that all TGAL pilots and other flight crew are trained and checked to ensure safe and efficient flight operations for the company. He has responsibilities for training, general document control, aircraft performance monitoring and several general management responsibilities including dealing with pilots' personal and operational issues and preparing the pilots' monthly roster.

The Safety Manager is responsible for ensuring that day to day operations of the company are carried out safely. He reports directly to the Accountable Manager and interacts on a daily basis, with the Director of Operations and the Chief Pilot with regard to pilot issues. He is responsible for establishing the Safety Management System to ensure independent monitoring of both TGAL and the maintenance provider company, Caribbean Aviation Maintenance Services (CAMS). He is also responsible for providing feedback to the Accountable Manager, to ensure that deficiencies are accurately identified and properly addressed in a timely manner.

1.17.3. TGAL Flight Operations Manual

The company's Flight Operations Manual (FOM) is currently at its 6th revision and has been approved by the GCAA. The manual is comprehensive and covers company administration, crew composition and their operating limitations, aircraft operations and training.

The flight crew component is sufficient for the aircraft operations and meets the flight and duty times limitations as detailed in the FOM.

The Operator has established a comprehensive Flight and Duty Time Limitations system which is intended to ensure that the maximum duty period is not exceeded, and to reduce the probability of fatigue of flight crew adversely affecting flight safety.

The PIC has the responsibility to ensure that all loads are properly distributed and safely secured and that a load sheet specific to the aircraft has been correctly filled out for each flight.

The FOM has detailed procedures that must be observed for refueling of aircraft. It states that measurement of fuel shall be done using the aircraft's fuel quantity gauges and with reference to the fuel delivery system's gauges.

It is required that the aircraft be equipped with serviceable HF communications for flights within Guyana that are outside the range of VHF communications. Aircraft must also be equipped with an ELT and a suitably sized and equipped Jungle Survival Kit.

Procedures for the carriage of Dangerous Goods (DG) is detailed in the FOM. It is stated that the company shall only transport DG if the safety of all persons handling, traveling with, and/or in the vicinity of such articles or substances is not compromised. DG must also be stowed in a manner to avoid leakage.

1.17.4. Safety Management System

TGAL has implemented a Continuous Monitoring Approach (CMA) safety system which is detailed in the company's FOM. It is stated that daily reports from pilots, engineers and flight operations staff will be dealt with promptly by the Safety Manager and the Safety Management Committee. Both scheduled and unscheduled safety assurance audits would be conducted regularly with the intention of ensuring that procedures are understood and are being adhered to. Among areas that must be covered by an annual audit are flight operations, ground handling and ramp procedures, Dangerous Goods and safety hazards, and aircraft refueling. Safety issues are discussed at weekly meetings held with operations staff and whenever pilot meetings are held.

1.17.5. Handling of Accidents and Occurrences

The FOM details procedures for handling of accidents and other occurrences. It includes accident notification procedures which requires notification to the GCAA and submission of a report to the Authority. It also states that reports must be made to ATC and 'Search and Rescue'.

The FOM outlines the emergency phases by colour and gives directions that the Duty Flight Operations Officer has to follow during the various phases which are identified as Code Yellow, Code Orange and Code Red. When the situation reaches Code Red it is handled by the 'Search and Rescue' and 'Emergency Rescue Committee' command center. The Duty

Flight Operations Officer is required to compile the 'Search and Rescue' profile in full and submit a copy to the command center, which will be located at the TGAL hangar, and fax a copy to ATC Timehri. The FOM further states, that the TGA Operations center will be the coordinating center for all 'Search and Rescue' and 'Emergency Rescue' operations.

1.17.6. Training

1.17.6.1. Flight Crew Training

The FOM lists the training required for the C208 pilot. Training includes initial ground school, which covers the aircraft systems; 25 hours of observer familiarization; briefing, which includes aircraft performance and various emergency procedures; 5 hours of flight training; the aircraft type technical examination and flight check; and line training and airstrip check. There is provision for de-briefs after each phase and additional training in each phase as may be required by the individual trainee pilot.

1.17.6.2. Training for Third Crew/Loaders

Training listed for aircraft loaders include initial and biennial recurrent training in the transportation and recognition of Dangerous Goods to be Shipped by Air, Initial and Recurrent Security Training, and Flight Operations Officer Training. Specific training for loaders is provided by both the Operations Department of TGA and the maintenance provider, CAMS. This training includes loading the aircraft within the Center of Gravity limitations and methods of securing (tying down) the load; maximum load allowed per section and floor loading intensity limits, including where information is placarded in the aircraft; use of floor boards; reporting of DG leakages etc. to supervisors; ramp safety; tie down lashing points; removal and installation of seats; operation of aircraft doors and tail support; and operation of seat belts. The FOM also mentions that loaders who are required to carry out duties away from base, are briefed by flight crew and trained by demonstration of the required tasks.

1.17.7. Operations at Olive Creek Airstrip

Olive Creek Airstrip, which is privately owned by the owners of TGAL serves as a hub for the company's aircraft operations in Region No.7. This location is accessible by road, which facilitates bulk stockpiling of diesel and other provisions. Aircraft fuel, AV JET, which is used to refuel the company's aircraft, is also stockpiled at Olive Creek. The stockpiled

Diesel is available for sale to miners in the area. M.C. Correia's Holdings mining operations in the Region are also provided with diesel from Olive Creek by means of shuttle operations which are done by TGAL. The accident flight was one of these shuttle operations.

There is no documented guidance specific to operations at this hub and operations there did not confirm to the company's operations manual. In this regard it was noted that during shuttles, the aircraft is loaded and unloaded with the engine running and no documented guidance is in place, however in practice, company reports suggest that staff are briefed and trained on safety precautions to be taken.

Refueling of aircraft at Olive Creek was done from drums of AV JET, which are stockpiled there. This refueling was done by a Grade 1A Technician/Aircraft Engineer LWTR, who is an employee of the AMO. Reading of the amount of fuel actually dispensed to an aircraft was totally dependent on the read-out from the aircraft gauges as there was no other means of verifying how much fuel was put into the aircraft. The engineer who was on-site at the time of the accident stated that he was not given a written document explaining his duties at Olive Creek but he was briefed about what to do. He was given theoretical training and OJT at Olive Creek.

The Safety Officer had never visited Olive Creek but he stated that he had arranged for audits to be done at Olive Creek and never found any problems.

There was no provision in place to ensure that load sheets were prepared and to ensure that the aircraft mass and balance was correctly adjusted for each flight.

1.17.7.1. Approved Maintenance Organization (AMO)

Maintenance for the aircraft operator is carried out by Caribbean Aviation Maintenance Services Ltd (CAMSL). The AMO is a member of the M.C. Correia Holdings group and is therefore a sister company of the Aircraft Operator, TGAL. The two companies share the same Accountable Manager. The AMO has the required management, supervisory and line staff to effectively carry out the tasks it undertakes and utilizes the AMEL system as the basis for maintenance certification.

The company provides contracted maintenance and record keeping to six other local aircraft operators, but more than 90% of its work is done for TGAL, which currently operates seven Cessna Caravan aircraft and one BN2 Islander aircraft. Two of the caravans, including the accident aircraft, were given the Black Hawk modification to include the PT-6A-42 PW&C engine.

The maintenance facility is located at Ogle International Airport and includes hangar space, offices, and several specialized workshops. Base and line maintenance is done on airframes, engines, instruments and propellers for aircraft below 5700kg. The company is approved to carry out these tasks on Cessna Single Engine Variants, BN2A Islander and BN2A-Mark III Tri-lander Series and Piper PA32-300 Series. The company also operates a fuel farm from which it dispenses fuel to TGAL and other operators.

The company has a quality department that carries out scheduled and unscheduled quality audits of the organization procedures, records, aircraft and equipment and the fuel farm.

The MPM details company policy with regard to administrative and technical procedures that provide guidance to staff in the execution of their duties.

Senior staff of the AMO stated that there is an "Away from Base Manual" that contains written procedures for refueling away from base, but does not include other instructions or guidance with regard to the duties of the engineer while working away from base. This manual was not submitted to the GCAA for approval nor was it submitted to the Accident Investigation Team. Mechanics are usually given training in refueling procedures.

1.18. Other Information

1.18.1. The Authority

The certifying authority for TGAL and CAMS is the Guyana Civil Aviation Authority (GCAA). The Authority does not have a resident Flight Operations Inspector and therefore is not staffed to carry out the required flight operations oversight responsibilities required for TGAL. The Authority has an arrangement with the Caribbean Aviation Safety and

Security Oversight System (CASSOS), which provides the services of Flight Operations Inspectors to Guyana quarterly or upon request as necessary. The Authority's staffing and facilities for maintenance oversight is satisfactory.

1.18.2. Search and Rescue Operations

1.18.2.1. General

The GCAA is the SAR Authority in Guyana and operates on a 24 hours basis. SAR is carried out by the RCC which is located at the Timehri Control Tower Complex at the CJIA. The Air Navigation Services Directorate is responsible for ensuring that the RCC is maintained and properly equipped and is always in a state of readiness for a SAR mission. Upon determination that an aircraft and its occupants are in an emergency and requires help, the Duty Air Traffic Controller in the Flight Information Center (FIC) immediately activates the RCC and initiates SAR operations until relief is provided by a senior officer of the GCAA, who will assume the role of SAR Mission Coordinator (SMC) until the Director General of GCAA designates a SMC. Other agencies that comprise the SAR organization includes the Guyana Defence Force (GDF), local aircraft operators, Guyana Police Force (GPF) and the Guyana Fire Service (GFS). Supporting agencies include the Ministry of Health and the Civil Defence Commission, who are all expected to contribute their resources to the operation as necessary.

Depending on the location of the emergency it may be necessary to establish another SAR sub-unit. This will necessitate appointment of an On-Scene-Coordinator (OSC). The OSC is responsible for coordination and operational control, including flight safety issues on the scene and coordinates all activities with the SMC. It is noteworthy that the GCAA Aeronautical Search and Rescue Plan requires efficient and effective communications comprising both primary and secondary means and the secondary must be able to function immediately in case of primary failure.

When it is confirmed that the aircraft and its occupants are in distress the RCC will go straight into the Distress Phase and take actions in keeping with this phase to expedite relief to the victims.

1.18.2.2. Actions Taken by the RCC

When he was notified of the aircraft in distress, the Duty ATCO asked the pilot who made the report, to call the distressed aircraft and he also tried unsuccessfully to contact the aircraft. In keeping with procedures established in the GCAA Aeronautical Search and Rescue Plan the Duty ATCO collated the available information and notified his supervisors. Other stakeholders including TGAL, GDF and GPF were also notified. Attempts were also made to contact USMCC for information on possible ELT transmissions as none was heard in any ATC facility. Aircraft that were flying in the vicinity of the accident immediately diverted and started aerial reconnaissance to try to spot the downed aircraft.

A senior official, who was notified of the accident by the DATCO, reported shortly after to the FIC and was briefed on activities so far. He was later appointed as the SMC. He confirmed the relay times and based on these estimates and the North coordinate given by the accident pilot, approximate time of departure and the time of the May Day call, a possible search area was plotted. This information was relayed to search teams including additional flight crews and GDF Special Forces. SAR units from the GDF Air Corps and Special Forces were mobilized and their representatives met in the RCC. Another senior official of the GCAA reported to TGAL, Ogle. There was continuous effort to obtain additional information from the aircraft operator.

TGAL's representatives arrived at the RCC very late in the afternoon and provided additional information which was used to refine the search area to a high probability area of 2nm radius. This information was passed to the search teams but by this time the search had to be terminated for the day, due to night fall. Later in the evening, pilots returning from the search briefed the RCC on the aerial search and interviews that were conducted on the ground. Plans were developed for the next day's search, including designation of an On-Scene-Commander (OSC) and an Aircraft Coordinator, both of whom would be stationed at Olive Creek for the duration of the search. The OSC was tasked to coordinate with all SRUs via radio on 121.9MHz and with the RCC via internet. The Aircraft Coordinator was tasked with coordinating flight activities during the search.

Operations on the second day began shortly after sunrise. The search resumed in the high probability area. More ground checks were done and a witness was found who was able to

give a good description of his last sighting of the aircraft. Confirmation of sighting of the wreckage was made by the GDF helicopter, during the afternoon of the second day. The site was marked at position N06 10 09.9 W060 09 03.42 and on a line 235° and 2.8nm from Olive Creek. This information was passed to the RCC.

1.18.2.3. Rescue/Recovery

The wreckage was in an area that was only accessible by helicopter. It was expected that a locally available helicopter would have been able to get to the site. However the GDF Special Forces were dropped into a spot that was more than a mile away from the site. They then walked through dense undergrowth in search of a suitable site to make a clearing for the helicopter to alight. The clearing was about ¼ mile from the crash site. The SF team divided into two groups. One group worked on the clearing for the helicopter, while the other walked on to the accident site. They were equipped with jungle survival kits and tools to move through the jungle. They were not provided with protective gear for recovery of the bodies or other possible contaminants. SF reached the wreckage early the next morning (the third day). Initially only the body of the pilot was seen and it was reported that he was dead. The body of the loader was later found buried under the drums. The next of kin were updated on this information.

The recovery was hindered as the aircraft had to be cut to extract the bodies. Completing of the clearing for the helicopter and cutting the aircraft was not completed until the fourth day when both bodies were extracted and brought out to Georgetown.

Accident investigators arrived at the site on the third day. After extraction of the bodies the site was handed over to the investigators.

INTENTIONALLY LEFT BLANK

2.0. ANALYSIS

2.1. Pilot

The pilot was a 25 year old male who was certified in accordance with the Guyana Civil Aviation Authority Regulations. There was no evidence of any pre-existing medical or behavioural conditions which may have adversely affected the pilot's performance during this flight. He was qualified and experienced to conduct the flight. Training records show that all required training was successfully completed. Route and airstrip checks were regularly done. His last Aircraft Proficiency Check (APC/IPC) was successfully done on aircraft type on 29th November, 2013. The next check was due in June 2014.

The pilot had resumed flying on 8th December, 2013 after fourteen days' vacation. He had flown 24:43hrs in the seven days immediately prior to the accident. On the day before he had flown 5:03hrs. His flight and duty times were well within limitations. He had acquired more than 2500 hours on type and was considered to be a good pilot.

The pilot was scheduled for two days of shuttling operations that would have required him to overnight in the hinterland. The accident occurred during the second day of this schedule. He had started the shuttle operation with another aircraft which was also subjected to the Black Hawk modification. During operations on the first day that aircraft experienced a hard landing, possibly due to gusting wind conditions. He had spoken to a few individuals about the hard landing and they were all of the opinion that he was very upset by this hard landing and had expressed concerns about how his company would react to it. The hard landing, combined with a subsequent brake failure and the concerns that were expressed by the pilot, caused the Chief Pilot of the company to instruct that the aircraft be exchanged. The aircraft that suffered the hard landing was inspected by the engineer on site and declared fit for flight and was flown safely back to base.

The pilot who did the aircraft exchange stated that despite the accident pilot's concerns he seemed to operate quite normally when he received the exchange. It was also reported that the next day he seemed to be operating normally prior to and up to the accident flight.

2.2. The Aircraft

2.2.1. General

The accident aircraft was one of two aircraft operated by TGAL, which was given the Black Hawk modification to include the PT-6A-42, PW&C engine. Maintenance records show that the aircraft was maintained IAW established procedures. Certificate of Airworthiness renewal was done on 8th January, 2014. The aircraft and all its records were inspected and found to be satisfactory.

2.2.2. Mass and Balance

No load sheet was prepared for this flight. The company management expressed the opinion that the paperwork could be burdensome for the pilot during shuttle operations and dispatch staff should have been stationed there to assist with preparation of load sheets and other paper work. The records done at Olive Creek were prepared not by aircraft operations staff, but by employees of the mining operations, whose records were only to ensure that whatever left Olive Creek on the aircraft was received at the destination. These persons were not trained or kept current by the aircraft operator, therefore there was no operational control of these persons.

The company explained that because their shuttle operations is standardized, an application, by letter dated December 13, 2007, was made to the GCAA requesting a dispensation for non-compliance with "GARS 8.1.4. and 8.6.1.2." which deal with requirements for load sheet for every flight. However review of the GCAA file shows that a base inspection conducted during November 2007 revealed that there were no load sheets for shuttle operations, contrary to GARS. 8.6.2.17. This non-compliance was notified to the company which responded by indicating that corrective action was taken. GARS 8.6.1.2. deals with the requirement to file a flight plan for all commercial flights.

2.2.3. Cargo Area

The aircraft can be operated either in the passenger or cargo mode, or in combination. For this flight the aircraft was being operated in full cargo mode. The Pilot Operating Handbook (POH) states that when operated in the cargo version, a maximum of one seat may be installed to the right of the pilot's seat for use by a second crew member or passenger. This

seat was installed but was not occupied. An additional seat was installed immediately behind the pilot's seat and was occupied by the loader.

The POH indicates that cargo partition nets, cargo barriers and various tie down belt assemblies and tie down ring anchors are available for securing cargo. It is stated that cargo restraint is necessary to prevent movement of cargo in five directions (forward, backward, upward and side to side) and is required for flight, landing, taxy loads and crash loads. Further when a cargo barrier is not installed, cargo must be prevented from movement in the five principal directions and secured to provide crash load restraint. The tie down method used was not effective because it in effect only secured the three drums that were lying flat on the floor. The four drums that were standing upright were not securely restrained and became projectiles. Evidence given by the first technician at the site indicated that the two foremost drums that were lying flat and had been strapped down were still in their original positions with the tie down straps intact. The other drums had moved and pinned both the loader and the pilot.

The aircraft operator has an approved cargo barrier but this was not in use because the POH requires that when the cargo barrier is used, all cargo must be loaded such that the loading zones forward of the last loaded zone must be 75% full by volume. TGAL was justified in not using the barrier as their cargo did not meet this requirement.

2.2.4. The Engine

The engine analysis Report No.: 14-004 dated 28 April 2014, was issued by P&WC Service Investigation Department. A Supplementary Report dated 13 May 2014 with one amendment to the original report was subsequently issued. The amendment advised that P&WC would issue SI-01-2013R3, requiring implementation of in-situ boroscope inspection for Cessna Caravan (Blackhawk) conversion operators. The report shows the following:-

1. The engine displayed severe impact damages to the external housings, fuel pump, fuel control unit and fuel to oil heat exchanger.
2. The engine displayed a compressor rotor distress due to a 1st stage compressor stator vane fracture by fatigue. The fatigue crack originated from

a lack of brazing adhesion and was located between the leading edge and mid-chord of the vane.

3. The compressor and power turbine blades were burnt and fractured by tensile overload. The power turbine rotor was found deported out of its rotation axis due to the power rotor unbalance after the power turbine blades fractured. One of the aircraft exhausts showed dents due to the impact of the power turbine blades release.
4. The compressor turbine vane ring was exposed to elevated temperature and showed impact damage at the trailing edge due to the impact of the compressor turbine blades fracture.
5. The power turbine vane rings were severely damaged by the power turbine rotor unbalance.
6. All controls and accessories analyses revealed no defects or damage evident that would have prevented normal operation prior to the event. The over-speed governor, the propeller governor and the torque limiter test results were suggestive of field rigging adjustment.

It was noted that the engine analysis included several references to the term "suggestive of field rigging". P&WC was asked if the field rigging is an approved action and if it was done in Guyana or by a sub-contractor to P&WC and what are the consequences if any. In response, P&WC explained that

"During the accessories tests, some parameters were found out of suppliers' maintenance manual limits. However, these parameters could meet the OEM limits. Because P&WC could not confirm if the parameters met the OEM limits, we use the term ''suggestive of field rigging''. During our investigation, no correlation could be done between the observed accessories parameters out of limits and the engine investigation findings (1st stage compressor vane stator distress). Consequently, the accessories parameters out of limits did not contribute to the event."

Additionally it was noted that installation of the engine for the Blackhawk Modification to this aircraft was done in Guyana by CAMS. This is recorded in the Engine Log Book and was done IAW the Maintenance Manual. The duplicate inspection was carried out. The

Engineers who carried out these tasks are so authorised in keeping with the provisions of their licences.

2.2.5. ETMS/ADAS

Analysis of the ADAS data showed that engine exceedences were recorded only during the final flight of the aircraft. Parameters showed fluctuations of the following engine components; compressor rotor rotation speed (Ng), Inter-Turbine Temperature (ITT), Fuel Flow (W_f), Propeller rotation speed (Np), and Torque (Tq). The fluctuations suggested that the 1st stage compressor stator vane had cracked and started to affect the engine performance. Analysis showed that the Ng dropped by 15.4% (5784 rpm) associated with loss of Tq, rise in ITT, drop of W_f and Np within 4 seconds. The fuel control unit tried to readjust the W_f to regain power.

After an undetermined period of time, the pilot elected to use the EPL. This resulted in the ITT, Ng, and W_f rising and the Np was stabilized but the Tq never reached more than 730lbs-ft. subsequently the ITT went very high and all other parameters went down close to zero; the engine did not regain power. A Tq peak was observed just before impact; this was attributed to the sudden stop of the propeller blades impacting trees during the aircraft's descent.

2.2.6. Flaps

The flaps were found positioned at approximately 10°.

2.2.7. Propeller

The Propeller strip report showed that all the propeller blades had mild damage. All four blades were bent aft at mid-blade due to impact. One blade was spinning freely in the hub due to a fractured blade knob. Propeller cycling was not possible due to damage.

The damage to the propeller indicated that the propeller was under very little or no power. There were no discrepancies noted that would preclude normal operation. All damage was consistent with impact damage.

2.2.8. Emergency Locator Transmitter

The ELT passed all RF transmissions and power output tests as per original design specification. Under the centrifuge test, it was found that the unit activated outside the G-

switch specification at 2.9Gs instead of within the design window of 2 – 2.6Gs. It was noted that the battery was replaced since manufacture and has an expiration date of 2017, but it was too weak to effect a self-test of the beacon with a dummy load attached to the antenna. However, the battery voltage and current were consistent with and within specification for its usage time.

The Nav Interface unit performed as per original specification.

2.3. Meteorological Information

Weather was within VFR limits and is not considered to be a factor in this accident.

2.4. Communications

Communications between aircraft operating at Guyana's hinterland airstrips and Air Traffic Services can sometimes be problematic. This may be due to the distance and the undulating terrain which blocks transmission. Additionally pilots sometimes fail to report movements in a timely manner. The flight plan for the leg previous to the accident flight was not received by ATS. This could have resulted in the search being conducted in the wrong area.

2.5. Survival Aspects

2.5.1. General

The pilot made a May Day call which was heard by several pilots who were operating in the vicinity. Two of them immediately reacted by heading in the general direction of the accident flight. Their intention was to try to spot the wreckage, as it is easy for an aircraft wreckage to disappear in Guyana's dense jungle. Unfortunately the searching pilots did not find the wreckage.

The wreckage was discovered one day after the accident but was not accessed until the next day. It was immediately obvious to the first rescuers at the crash site that the crash impact had caused the pilot to be pinned by the backward movement of the dashboard and the

forward movement of the cargo. The loader who was seated behind the pilot was not immediately seen. He was later found pinned beneath the cargo.

2.5.2. RCC Operations

Officers in the RCC initially plotted a search area, based on information that was available immediately after the report. This search area was briefed/relayed to pilots who were already out searching. However this information was not accurate and resulted in wasted time and effort. The SAR Mission Coordinator was appointed within one hour after the accident.

Consolidation of efforts in the RCC was not achieved until almost six hours after the accident, when senior representatives from the operator and the aviation private sector turned up. The arrival of these persons brought additional skills and resources to the RCC. Information that had been retrieved from the aircraft's spot tracker was now made available. One of these persons is a subject matter expert who was able to use this information to assist in refining the search area.

The availability of SAR equipment was not satisfactory. The RCC failed to recognize the need for a more suitable helicopter than was available locally. This caused a delay in both location and extraction from the wreckage.

2.5.3. Search and Recovery

The wreckage was spotted during the second day of the search, but was not accessed until the next day. The bodies of the victims were not removed until the fourth day after the accident. Reaching the site proved to be quite difficult. Information initially provided to the RCC gave the assurance that the locally available helicopter would have the necessary capability to access the site and facilitate extraction, but this was not so. Based on this assurance no alternate arrangements were made to access more suitable equipment from overseas that would have expedited the recovery exercise. Further the need to cut the aircraft to free the bodies also proved to be quite time consuming. The lack of suitable equipment contributed to the delay in getting to the wreck and recovery the victims.

2.6. Organization and Management - TGAL

2.6.1. Staffing

This company has a reputation for maintaining and ensuring high operational safety and maintenance standards. The senior technical staff were found to be very well qualified and skilled for their various portfolios. Most of the company staff that were interviewed displayed intense pride in the company and were satisfied that their operations were of a very high standard. Generally the Chief Pilot was considered to be very approachable and he did display concern for the pilots and other staff whom he supervised.

2.6.2. The Flight Operations Manual

The company's Operations Manual is a very comprehensive document. However the company seems to have difficulties implementing some of the procedures and requirements stated therein. The requirement for redundancy in determining fuel quantities metered to aircraft was not met at Olive Creek because there was no measuring device attached to the fuel dispatch system.

The intent of the CMA is commendable however, this accident revealed several weaknesses in implementation. Most notable is the absence of physical audits of the away from base operations and the absence of guidance to all levels of staff involved in away from base operations.

The statement in the Manual that the TGA Operations center will be the coordinating center for all "Search and Rescue" operations is misleading. This section needs to be reworded to reflect TGAL as the coordinating center for its own aircraft that may be missing and recognizing its subservience to the GCAA RCC.

Although the Manual states that Dangerous Goods would not be carried unless the safety of persons travelling with it is not compromised, the DG cargo of fuel was not properly secured to prevent its movement in all five directions.

2.6.3. Training

The company provided training for its pilots in keeping with the requirements as stated in its Operations Manual.

The training detailed for third crew/loaders is comprehensive. However the Operations Superintendent, who is identified as the lead person to conduct this training, is not qualified as a trainer. Also, while he has many years of experience as an operations officer, he has not done flight dispatcher training. Thus although the company does both international and domestic scheduled and charter operations, it does not have a qualified flight dispatcher.

2.6.4. Operations at Olive Creek

Although the Safety Manager had never audited operations at Olive Creek, officials of the company considered that the operations there were safe. They expressed the view that the operations were being done safely there for years without mishap. The Safety Officer also stated that whenever shuttle discussions were held he would be assured by the Chief Pilot and Operations Director that the shuttle loads were within legal limits.

Operations away from base are not included in the FOM and there is no guidance specific to operations at Olive Creek.

2.7. Other Information

2.7.1. The Authority

Without a resident Flight Operations Inspector, The GCAA cannot provide the oversight that is necessary to ensure safe aircraft operations in Guyana. The FOI is the officer who is responsible for reviewing company operations manuals and for inspecting the companies to ensure that their operations are in compliance with the approved manual. Except for the occasional inspectorate visits by CASSOS Inspectors, ongoing routine and ad hoc inspections are not done. Thus tracking of aircraft operations are not monitored as required. However the Authority has a complement of qualified Airworthiness Inspectors.

2.7.2. SAR and the RCC

The actions of the DATCO who initiated the RCC were commendable. There is a very obvious need for regular review of the SAR Manual and the need for regular exercises to be held, to ensure that stakeholders are kept up to date with its contents and the requirements therein. The need for training, especially for GCAA staff in this area was reiterated. It was

noted that the OSC had only very basic training more than five years ago. The satellite phone that she was provided with was not activated and therefore was of no use.

The initial lack of cooperation from the aircraft operator hampered planning in the RCC and caused much wasted time and effort on the part of both the planners in the RCC and among the advance searchers. However, during interviews, several Company officials stated that as far as they were concerned, the RCC was established at Ogle Airport immediately after the accident. They were aware of the request for a company representative at Timehri, however they felt that it made no sense to rush up to Timehri when everything was happening at Ogle. They all stated that the presence of a senior officer from the GCAA reinforced their belief that the RCC was operational at Ogle. Even after that official left Ogle, they were in constant contact with that official, therefore there was no lack of information to the RCC at Timehri.

The company's Director of Operations stated that the GCAA official who was at Ogle was privy to all information including information from the spot tracker. He stated that he did not speak to the designated SMC but was always in contact with the official who was earlier at Ogle and he assumed that that person was in charge of the RCC at Timehri. The SMC indicated that Spot Tracker information was not made available to the RCC until after the company officials arrived there some six hours after the accident. He stated that this information along with some other information that became available after the first search teams returned from the search definitely proved helpful in locating the wreck.

The GCAA official who reported to Ogle was invited to explain her role but did not avail herself of the opportunity to do so.

The TGAL Director of Operations also stated that he was disgusted by the SAR system because although meetings were held and there is a SAR Manual, there is not enough follow through and every time there is a real occurrence there is much confusion. He expressed the need for the manual to be activated and regular exercises to be held. Several persons who were involved in the SAR mission agreed with these sentiments.

INTENTIONALLY LEFT BLANK

3.0. CONCLUSIONS

The investigation revealed that the probable cause of the accident was due to a power loss suffered by the engine. The power loss was associated with the fracture of one of the 1st stage compressor stator vanes by fatigue. The fatigue crack originated from a lack of brazing adhesion extending over approximately 0.280 inches along the chord length and 0.050 inches in the direction of the shroud thickness and was located between the leading edge and mid-chord of the vane.

3.1. **Findings**

3.1.1. General Findings

1. The flight was one of a series of cargo shuttles that had originated the day before the accident, with another aircraft that was fitted with the Blackhawk modification.
2. The hard landing followed by the brake failure that occurred on the originating day had upset the pilot and caused him much concern.
3. A decision was taken to replace the original aircraft being used by the accident pilot with another one, which was also fitted with the Blackhawk modification.
4. The pilot had completed five shuttles on the day of the accident. The sixth shuttle was the accident flight.
5. The weather was satisfactory for VFR operations.
6. There was no fire.
7. Both the pilot and the third crew/loader were killed in this accident.
8. This accident occurred 2½ minutes after take-off.
9. The wreckage site was difficult to access, this along with unavailability of suitable equipment, contributed to the delay in extraction of the bodies.

3.1.2. The Aircraft.

1. The aircraft possessed a valid Certificate of Airworthiness and there were no outstanding maintenance issues.
2. The aircraft was destroyed in the accident.

3. The aircraft engine was newly installed in June 2013 as part of the Blackhawk modification to the aircraft.

4. Engine trend monitoring was done by the ADAS.

5. The exceedences revealed by the engine analysis occurred only during the accident flight.

6. The engine lost power and the pilot manipulated the EPL, but the engine did not regain power.

7. The engine lost power due to the fracture of one first stage compressor stator vane by fatigue.

8. The propeller report indicated that the aircraft crashed under little or no power.

9. The Spot Tracker, although not an aviation approved device, provided good reference information that was used to refine the search area.

10. The ELT installed in this aircraft did not activate when the aircraft crashed, but analysis revealed that it functioned satisfactorily under test conditions.

3.1.3. The Pilot – Ops/Human Factors

1. The pilot was properly trained, qualified and licensed for the flight.

2. The off duty/rest time provided by the company was in keeping with the requirements of its Operations Manual.

3. The pilot did not communicate the flight leg prior to the accident flight nor his departure time from Olive Creek of the accident flight.

4. He recognized the loss of power and attempted to restore same by activating the EPL, but the aircraft did not regain power.

3.1.4. Cargo Operations

1. The aircraft was being operated in full cargo mode for this flight. The cargo was seven drums of fuel.

2. The company had no system in place for preparation of load sheets for shuttles from its sub-base, Olive Creek. Thus none was prepared for this flight.

3. The tie down method used was not effective because it only effectively secured the three drums that were lying flat on the floor. The four drums that were standing upright were not restrained.

4. The drums that were not restrained shifted during the crash and squeezed both the pilot and third crew/loader.

5. The third crew/loader was seated behind the pilot and alongside the cargo.

3.1.5. The Aircraft Operator

1. The company operates domestic and international charter and scheduled flights.

2. The company is properly staffed to satisfy the requirements of its operations.

3. The maintenance provider performs satisfactorily.

4. Although the company's FOM is a very comprehensive document, there are some areas that require review and implementation. These include;

a) Need to document guidance/directions for away from base operations.

b) Review of the CMA to ensure that there is more active and effective monitoring for away from base operations.

c) Review of the Emergency Procedures to clarify SAR procedures so that TGAL is listed as the coordinating center for accidents involving its own aircraft and recognizing its subservience to the GCAA RCC.

3.1.6. The GCAA

1. There is no resident Flight Operations Inspector. Therefore the Authority is not positioned to provide adequate flight operations oversight to the industry.

2. The Authority is not doing enough to ensure that stakeholders are kept up to date with the Aeronautical SAR Manual. This resulted in some confusion during this event.

3. Initial and recurrent training is not being provided to staff who are required to function in the RCC.

4. Regular training sessions need to be conducted for both staff and other stakeholders to ensure their currency and to allow them to function efficiently and effectively in the RCC.

3.1.7. P&WC

1. P&WC reported that since 2012 there have been two occurrences, inclusive of the current event, of an airfoil liberation from the 1st stage compressor stator on PT6A-42A

engines installed in a Cessna XP42A. Investigation of both occurrences showed that there was weak adhesion at a braze joint at the junction of the airfoil and stator ring.

2. P&WC stated that following the previous case of weak adhesion, they had issued a SI that was applicable only to the Skydive Fleet of XP42A aircraft due to their specific flight mission. This was based on P&WC's assessment of the data available at the time. This assessment was flawed as it did not allow other operators to be privy to the information available to the Skydive operator.

3. By limiting the applicability of this SI, other operators were denied the opportunity to carry out the recommendations contained in the SI, which may have been applicable to them.

4. P&WC should have taken more effective action to ensure that its clients are made aware of the previous failure and advise them accordingly of the actions to monitor and safeguard against the failure.

INTENTIONALLY LEFT BLANK

4.0. RECOMMENDATIONS

4.1. GCAA

1. The GCAA must recruit a qualified and experienced Flight Operations Officer.

2. The GCAA must carry out regular simulation exercises in keeping with requirements of the SAR Manual to improve the currency of stakeholders.

3. The GCAA must provide training opportunities for its staff and other stakeholders in RCC Management and SAR Operations.

4. The GCAA must ensure that all AOC holders institute a system for preparation of load sheets for shuttle operations.

5. GCAA must ensure that all AOC holders present documentation that will give their pilots, engineers and other staff, guidance and directions for operations away from base.

6. GCAA must advise all operators to review the installation and operation of their ELTs to ensure that they function as required.

7. GCAA must advise all companies to review their tie down methods to ensure that cargo is prevented from moving in any direction.

8. GCAA must advise all operators to remind their pilots of the need to transmit/broadcast every aircraft movement in keeping with requirements.

4.2. TGAL

1. The company must do a thorough review of its FOM, prepare the necessary amendments and submit these to the GCAA for approval. Items for review must include; procedures for away from base operations; review of its CMA to include scheduled and unscheduled inspections for sub-base operations; review of role of the company's RCC.

4.3. P&WC

1. P&WC should review its decision making process to ensure that findings of failures and the corrective actions thereto are fully notified to its clients. This will allow them to monitor and take actions to safeguard against the failure.

5.0. ACTIONS TAKEN SINCE THE ACCIDENT

5.1. Actions Taken by the Operator

1. A refueling truck with measuring gauges is in place at Olive Creek. This provides for two independent means of verifying the amount of fuel dispatched to aircraft.
2. Fuel records have been upgraded to ensure that proper aircraft fuel records are kept.
3. The operator has reduced the fuel shuttle load to six drums instead of seven. The six drums are laid flat on the floor and are strapped in place.
4. The loader is now seated behind the cargo.
5. Flight Operations staff is now in place at Olive Creek to do necessary paper work for each shuttle.
6. The company is complying with the Special Instruction #SI-32-2014 issued by P&WC.

5.2. Actions Taken by P&WC

1. As a containment action, P&WC has issued a Special Instruction #SI-32-2014 to implement an in-situ boroscope inspection for the Cessna Caravan (Blackhawk conversion) operators.
2. P&WC has incorporated changes to the braze process methods to improve braze adhesion. Stators including these changes are identified as 3107061-01 RE 62 and are available for field and production engines
2. P&WC has carried out a sampling programme on braze joints incorporating the above mentioned braze improvements. The sample results did not reveal any areas of incomplete adhesion between the airfoil and stator rings.
3. The stator P/N with the braze improvements described above, will be introduced by an SB to be released during October 2014. This SB will include a list of engine serial numbers that are required to upgrade their stator with the new configuration. This new P/N will not require special field inspection.
4. P&WC has introduced this improved braze process to the PT6A-41 and PT6A-42 engines using the same part number.