CIVIL AVIATION ACCIDENT REPORT NO CIA 161

FEDERAL REPUBLIC OF NIGERIA

MINISTRY OF TRANSPORT AVIATION & COMMUNICATIONS
AIR TRANSPORT HEADQUARTERS
14 BROAD STREET, LAGOS.

REPORT ON THE ACCIDENT TO
BRISTOW HELICOPTER (NIG.) LTD
HELICOPTER REGISTERED 5N–AJY
AT EKET OFF-SHORE ON THE
24TH FEBRUARY 1991

FEDERAL MINISTRY OF TRANSPORT AND COMMUNICATIONS
AIR TRANSPORT HEAD QUARTERS

ACCIDENT INVESTIGATION BUREAU
.....DEPARTMENT

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Ref. No.-CIA.161/06/92/
2ND JUNE,1992

The Honourable Minister

Federal Ministry of Transport and
Communications,
Air Transport Headquarters,
14, Broad STREET,
Lagos.

Final Report on the Accident to the Bristow Helicopter Bell - 212 Aircraft Registered 5N-AJY at Eket Off-shore Near BOP Oil Rig_ on the 24 February 1991

I have the honour and the privilege to submit the Civil Aviation Accident Report No. CIA.161 compiled by Mr. Remi Faminu, an inspector of accidents from this Bureau, on the circumstances of the accident to the helicopter registered 5N-AJY, which occurred at sea off Eket, Akwa Ibom State on the 24th February 1991.

Yours respectfully,

K. K. O. SAGOE, Deputy
Director, Accident
Investigation Bureau.

AIRCRAFT DATA

Type	- Bell 212
Registration	- 5N-AJY
Serial Number	- 30631
Date of Construction	June 1974
Manufacturer	Bell Helicopter Company P. O. Box 482 Fort Worth,Texas 76101,USA
Owners	Bristow Helicopters (Nig) Ltd,General Aviation Centre P. O. Box 11 MMA –
Operator	Owners
Airframe Time	21,881 hours
C of A Validity	1st September 1991
Power Plant	2 Pratt & Whitney Engines
Model	PT6 - 3
	No. l No. 2
Serial Numbers	PS.60481 CP.60752
Time Since O'Haul	3982 Hrs 3102 Hrs
Time Since New	16258 Hrs 15883 Hrs
Manufacturer	Pratt and Whitney Canada
Souls-on-Board	13
Perished/survived	9/4
Time of Accident	1550 Hours UTC
Date of Accident	24Th February,1991
Place of Accident	2 miles South of BOP Oil-Rig near Eket, Akwa Ibom State
Reference Point	N04º 12 mins E.008º 02 mins

All times are Universal Coordinated Time (UTC), which one hour behind the Nigeria local time.

PERSONNEL INFORMATION

Pilot-in-Command	Capt Micheal A. Parish
Age	54 Years(3rd June,1935)
Nationality	British,Male
Licence	ATPL No. 4119(H)
Validity	20Th May 1991
Total Flying Time	6873Hours
Total on Type	219 Hours
Co-Pilot	Olushola O. Ishola
Age	30Years(19Th May,1960)
Nationality	Nigerian,Male
Licence	CPL No. 3520(H)
Validity	2Nd April,1991
Total Flying Time	1,364 Hours
Total on Type	131 Hours

LIST A CASUALTIES

1.	F/0 0.0. Ishola	31 years
2.	Nsikak 0. Archibong	31 years
3.	Effiong Andem	42 years
4.	Patrick Ngah	42 years
5.	Okon M. Udo	25 years
6.	Bassey Edem	27 years
7.	Sunday Inyang	26 years
8.	Emmanuel W. Udo	30 years
9.	Ramani Aironomi	38 years

LIST B - SURVIVORS

10.	Capt. M. A. Parish	54 years
11.	H. Pennison	63 years
12.	Ron Armstrong	59 years
13.	Hope Enaibre	35 years

Notification of the Accident

The information about this **accident was sent to the Deputy** Director of Accidents' Office at the ministry's headquarter in Lagos about 1030 hours UTC and an inspector of accidents was immediately despatched to Eket, Akwa Ibom same day to commence the investigation into the cause of the mishap.

Synopsis

The accident occurred towards the end of the day's sorties and it was the turn of the co-pilot to fly the last segment of ASABO-BOP-IDOHO-EKET. Departure from the Oil-Rig ASABO to BOP was normal until descent to the BOP platform.

At the beginning of the descent from 700 feet the F/O was still flying, until they heard a bang noise accompanied by a yaw to the right hand side and the captain quickly took over the control from his co-pilot. The captain said that he thought they had a tail rotor failure so he started to apply corrective measures for a tail-rotor disability.

The captain must have over-reacted to his anticipations by nose dipping the aircraft into the water instead of flaring onto it. The floatation gear got inflated when the sensors came in contact with water helping to over-turn the aircraft under water deployed over it. Nine souls, including the co=pilot's were lost and four survived the accident. All the deceased, except the co-pilot, died without their seatbelts fastened. Three of the survivors escaped through the same emergency exit while the captain came out through his own flight deck door.

1. FACTUAL INFORMATION

1.1 History of Flight

Bristow operates helicopter flights for the Mobil Oil offshore operations, and 5N-AJY was No 1 aircraft on the afternoon flight schedule of the client.

The third tasking of the afternoon commenced with refueling at IDOHO platform at about 1550 hrs. The routing for this tasking was IDOHO - ADUA - EKPE ww - ASABO - BOP - IDOHO - EKET on the mainland all others are off-shore oil rig platforms. The first half of this routing was flown by the captain while the co-pilot was to assume the second half at ASABO, which he did. Incidentally, this was the first time the crew had been paired up for duty and the captain maintained that working together had been a pleasure.

Departure time from ASABO was 1642 hours and the aircraft climbed to the transit altitude of 700 ft. In cruise, the aircraft was flown at 65% torque with the airspeed of between 95 and 100 knots. There were on-board, 13 souls and 900 Ibs of fuel. The helicopter had been cruising for 7 minutes and had to commence a descent in order to make an approach to landing on the Berth Operations Platform (BOP) after passing between INIM platform, and its gas flare, which is the normal routine track. The captain stated that whenever operating over water the floats are always selected in the ARM position, and so, the floats were armed on this

After the helicopter had been descended to 400 feet altitude and was slowed down for the approach landing, the co-pilot called for pre-landing checks, which the captain had just started to enumerate when there was a sudden BANG from the back of the aircraft followed, instantaneously by a sharp yaw to the right and followed by a sharp pitch down. Obviously, the captain quickly took over control from the younger and relatively inexperienced pilot, the pilot instantly entered the aircraft into autorotation thinking that they had a tail rotor failure. The pilot-in-command said he diagnosed a tail rotor failure and initially thought that the aircraft was controllable. The pilot started to implement emergency procedure for a tail rotor 'failure and broadcast a "May Day" which he was not sure was transmitted because he and the co-pilot had been talkinq to each other on the intercom mode. After a short while (about 4 seconds), the commander claimed the control responses became normal but by this time he had nearly reached the sea and'he started to raise up the nose to reduce rate of descent. He said he told his co---pilot that he was ditching and there was s no time to warn. the passengers through the passenger announcement system. The commander also gave evidence that as the aircraft slowed down he told the co-pilot, as he (the captain) flared, that he would close the throttles as soon as the aircraft started to yaw, and the aircraft landed quite heavily onto the sea with a side-ways component due to 30° - 40° of yaw and overturned upside down.

The accident occurred 25 mautical miles at sea, geographical reference point 04° 12 mins North and 008^{W} 02 mins East. Time of the accident was 1550 hours UTC.

1.2 INJURIES TO PERSONS

Injuries	Crew	Passengers	others
Fatal	1	8	Nil
Serious	Nil	Nil	Nil
Minor/None	0/1	0/3	

1.3 DAMAGES TO AIRCRAFT

The following damages were found owing to impact with water:

a. Co-pilot and captain's side lower nose section window (chin window) broken.

b. Co-pilot's side honey-comb nose forward chin window crushed-in and broken (implosion).

c. Co-pilot's fiberglass nose section cracked radially at area above chin window.

d. HF. whip antenna broken (co-pilot's side).

e. Co-pilot's left pedal plate torn off at rivet points (3 out 4 rivets sheared off) and became distorted:

f. Co-pilot's Skylight window broken

g. Left side engine in-take cowl and pylon buckled.

h. One Main Rotor Blade (MRB) pitch horn suffered sheared bolts and became detached.

i. One Main Rotor Control tube fractured due to massive compressional over-load.

j. Portboard elevator/horizontal stabiliser suffered fractured tube and the surface was destroyed.

k. Fuselage underside dented.

I. One MRB face completely overturned up-side down.

m. Main transmission rear mount, bolts pulled out of place.

n. Co-pilot :door. below the handle buckled in.

o. Total loss of hull due to salt water contermination of major components and doubtful structural integrity of the airframe.

1.4 OTHER DAMAGE

There was no other damage at sea

1.5 PERSONNEL INFORMATION

1.5.1 The pilot-in-command is a 54 years old British male national issued with a Nigerian Airline Transport Pilot Licence No. 4119 (H) on the 29th November 1990. The captain arrived in Nigeria in October 1990 and passed his "Air Law" examination in November upon which his British ATPL was converted to the Nigerian ATPL.

Captain Parish had a total helicopter flying experience of 6,873 hours, of which 219 were on type. He had flown chipmunk, Hiller 12E, Bell 47, Scout MBE 105D and SA 365 before arriving in Nigeria to fly Bell 212, which is his heaviest helicopter experience. His licence was valid till 30 May 1991, his rest period was 19 hours and, he was fully qualified to take the flight. The commander also doubles as the units meal planner, who oversees the daily meals of Bristow's Eket staff in addition to his flying duties, hence his low daily flight hours.

1.5.2 The co-pilot was a 30 year old Nigerian male issued with a Nigerian Commercial Pilot Licence No 3520(H) on January 24th 1991. The co-pilot was initially a fixed wing pilot having acquired a fixed wing experience of 1,138 hours before converting to rotary wing flying. His total flying experience amounted to 1364 hours, 35 of which were on type.
He was predominantly a twin Otter DHC-6 Pilot and he had 888 hours on this type before travelling to his company's Redhill headquarters in June 1990 to undergo a rotary wing convertion training in England. He returned to Nigeria in January 1991 and resumed flying as Bell-212 helicopter pilot. The co-pilot had 18 hours rest period before assuming duty at noon on the day of the accident. His CPL licence was valid till 17 June 1991 and was therefore found qualified to take the flight that day.

1.6 AIRCRAFT INFORMATION

Bristow does the maintenance of its rotary and fixed wing aircraft and the company's maintenance practices have never been in question with the Airworthiness Division of the FCAA.

5N-AJY had been flying in Nigeria for many years and had accumulated the total airframe time of 21,881 hours before this mishap. No defect was known to have existed on the aircraft before the accident. The certificate of airworthiness was valid until 1st September 1991.

The aircraft was certificated for an All-up-weight of 10,860 pounds. The actual weight at take-off ASABO was 10,650 Ibs consisting of 11 passengers, 2 crew and 900 Ibs of Jet A-1 fuel. The centre of gravity position was found to be within the acceptable limit, and therefore not a factor in this accident.

1.7 METEOROLOGICAL INFORMATION

The off-shore forecast for that afternoon operation was:

Cloud	-	4 OKTAS Q 3000 ft.
Temp	-	28^0 Celcius
Wind	-	260^0 O 10/15 Knots
visibility	-	Several Kilometres
Weather	-	Bright and Clear
QNH	-	1013 hPa

1.8 AIDS TO NAVIGATION

No aids at sea

1.9 COMMUNICATIONS

The surviving crew gave evidence that there was no communication problem prior to the accident but on -transmitting 'MAY DAY' he was not sure whether he actually switched from intercom to transmitting mode before the MAY DAY' call. However, two rescue boats in the vicinity of the accident came rushing to the spot of the accident within 25 minutes and rescued the survivors. Earlier than the boats was a Bristow helicopter which approached within 7 minutes and hovered for some time before disappearing again.

1.10 AERODROME INFORMATION

The intended landing point of the aircraft was the Berth Operation platform (BOP) an oil rig platform of about 25 nautical miles from Eket main-land. The aircraft was still about 2 miles from the platform when the accident started to happen but it went past the landing pad and ditched into the sea.

1.11 FLIGHT RECORDERS

The aircraft was not required to carry either a Cockpit Voice Recorder or a Flight Data Recorder.

1.12 WRECKAGE AND IMPACT INFORMATION

The helicopter went into the water and broke Chin window acrylic plastics of the nose section. The co-pilot's side of the honeycomb in that section and the HF Whip Antenna which was attached to the co-pilot's side were broken. Other-wise every other part of the aircraft looked intact except for the damages which are enumerated in chapter 1.4 of this report.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

9 Medical Certificates of cause of death were issued by Immanuel General Hospital at Eket, Akwa Ibom State on the co-pilot and the eight passengers. All of them having primary cause of death as "asphyxiation" and the secondary cause as "drowning/suffocation due to Helicopter accident at high sea."

The survivors were taken to a clinic for observations and were later released.

1.14 FIRE

No fire occurrence.

1.15 SURVIVAL ASPECT

The accident is survivable. But death by asphyxiation depends on individual's ability and capability to survive under water for a few minutes.

1.16 TESTS AND RESEARCHS

The helicopter was hauled from water the very day of the accident but was not brought into the hangar owing to road transportation problem. It finally arrived at the hangar on the following day of the accident at about 1530 hours UTC, when this inspector and two other Bristow Officials from Redhill - Messrs F.W.H Chammings from the Engineering and Capt. Mike G. Griffin from the Flight Operations, started looking into what might have caused the accident. The team was later joined by Airclaims Insurance Representatives, Mr. David Gee and Bell Helicopters from Texas USA was represented by Mr. Joe Syslo who arrived when this Inspector of Accidents had returned to Lagos on another assignment.

In the hangar, internal and external inspections were performed from the Main Rotor (MR) down to the Tail Rotor (TR) drive

1.16.1 THE MAIN ROTOR

An attempt was made to hand-rotate the main rotors but there was a stiff resistance which prevented a 360° rotation. More force was applied by someone climbing over the fuselage in order to put more torque on the main rotor but the rotors would not move beyond a certain angle of rotation. So it was decided that the source of the stiffness be traced and each component was gradually separated and observed.

1.16.2 THE MAIN TRANSMISSION GEAR BOX

The Main Transmission Gear Box was removed and inspected, but the drive train was faultless and was decided upon there and then that it was not necessary for oversea shipment. So The Main Transmission Gear Box was left behind at the Operator's hangar at Eket.

1.16.3 THE TAIL ROTOR

The tail rotor drive shaft segments were removed and inspected. The tail rotor gear box was inspected for any discrepancies that might have led to any tail rotor failure so also was the tail rotor controls but no discrepancies were found which made the investigating team to conclude that there was no tail rotor failure.

1.16.4 THE POWERPLANT AND THE COMBINING GEAR BOX

When the engines and the combining gear box were removed from the airframe, it was observed that the turbine disc of the No. 1 engine could not be rotated freely by hand, but the No. 2 turbine disc could be freely rotated. The twin pack power plant and the combining gearbox were requested to be shipped overseas for detailed inspection at Bristow Redhill facility.

Present for the disassembly at the Bristow Redhill facility were this Inspector of Accidents, representing the Nigerian Accident Investigation Bureau, Mr. John Nkongoli representing the Service Investigation Department of Pratt & Whitney Canada Inc - the Engine Manufacturer; The combining gear box is also manufactured by Pratt & Whitney of Canada): Mr. Chris Pollard represented the British Air Accident Investigation Board in Farnborough. Mr. David Gee came and represented Airclaims the Insurers. Mr. R. W. Murley, the Overhaul Manager, Power Plant and Transmission led the Investigating team of the Bristow Helicopter (Redhill) Ltd. and among the team was Mr. Frank Chammings, who was also the Bristow Helicopters Investigating Engineer at Eket Hangar.

On the disassembly of the two engines and the combining gear box, no engine fault or damage was found and the result of our negative find was telephoned to the engine manufacturers in Canada, who insisted that the investigation must continue into the engine accessories at their own facilities at Longuieuil, Quebec, where best facilities and laboratories to look further into the accessories are available. It must be stated that salt water had grossly attacked and decomposed the magnesium alloy material which the engine was made of.

So from England, this Inspector of Accidents hand-carried the following accessories to Canada:

a. Manual fuel Control - S/N A56391

b. Manual fuel Control - S/N A15889

c. Authomatic fuel control unit- A8997

d. Authomatic fuel Control unit – A10482

e. Fuel pump one - PE5911

f. Fuel pump two - PE8047

g. Compressor Bleed Valve one - " A29206

h. Compressor Bleed Valve two - " A4316

i. Power Turbine Governor Engine one - " A4273"

j. Power Turbine Governor Engine - " A9585

k. 2 compressor turbine blades from engine #1

I. 2 compressor turbine blades from engine #2

Present' at the test bench analysis and disassembly of some components were Mr. Jean Crete leading the Pratt and Whitney workshop engineers, Mr. Otto Kraus, P & W; Mr. Frank Vancura was representing Bendix Avelex the manufacturer of the Manual and Automatic Fuel Control Units and the Compressor Bleed Valves. Mr. Christian Vielleuse was the Lead Airsafety Engineer of Pratt & Whitney Canada, while Mr. Michael Perodeau was the Engineering Manager at the Service Investigation Department of Pratt & Whitney, Canada. The results of the analysis performed on these components are listed on the appendix section of this report. It could be noticed that every. test came out right except the performance of the two compressor Bleed Valves which are narrated here under section 1.16.5.

1.16.5 COMPRESSOR BLEED VALVE - PT6 ENGINES

The valve is a piston-type in a ported housing. It is bolted to the gas generator case inner section. The bleed valve remains opened at low compressor speeds and remains closed at higher speeds. The piston is supported by a rolling diaphragm, which permits full travel in either direction, while effectively sealing the compartment below the piston. There is only one bleed valve per engine.

At Pratt & Whitney facilities, the bleed valve associated with engine No. 1 was installed for calibration check, it was found to be leaking at 30.2 inch of mercury test, and there was no pressure build up on top of the piston. Investigating the cause of leakage was to disassemble the component and it was discovered that the bleed valve cover was installed 180° from the required position which permitted the control pressure (Px) to the very low.

There was an entry made into the Component Log Card of the bleed valve at the Time Since Oveihaul, of 3224:40 i.e. 758 hours prior to the time of the accident, that the "diaphragm replaced" on the compressor bleed valve serial number A29206: it was then fitted to AJY at the airframe time of 21123:40. The helicopter crashed at 21881 hours.
The Second Compressor Bleed Valve Serial Number A4316 was also installed on the test bench for calibration check. When the test barometric pressure of 14.83 Psia was applied the result of 17.55 psia was obtained whereas acceptable minimum value is 17.60 psia. The valve was disassembled and it was discovered had kinked and was pinching between the piston and the piston housing (please see appendix 2B) Although, it was not indicated in the component log card that this valve was opened up in the field, but it was observed that the type of the grease applied to the wall of the housing had become sticky and could have induced the diaphragm to experience restrictive movement in its up and down motions.

1.16.6 FLOATATION GEAR

The float equipment on this aircraft is the type with water sensors; which, if in the ARM position, is automatically inflated when in contact with water.

1.17 ADDITIONAL INFORMATION

There were 13 souls on board this aircraft of which 9 did not survive the accident, including the co-pilot who was known to be a good swimmer. Incidentally, eight of the victims did not have their seat belts on but the co-pilot did. The 8 bodies were recovered floating within the cabin.
All the survivors are foreigners except Mr. Hope Enaibre, who is a Nigerian and was seated in the main cabin. The captain was in his rightful place occupying the right cockpit seat; while the two other surviving foreigners were sitting on the left hand side - facing well-seat (figure 1). The three surviving

1.17.1 SURVIVOR NO. 1

Mr. Ron Armstrong is a 59 year old British passenger occupying the no 12 position in the left well-seat (figure 1) Mr. Armstrong stated that the aircraft had passed INIM flying towards BOP when the helicopter gave a huge shudder then started to descend rapidly at a fast speed. It then hit water and turned over. The passenger area was filled completely with water while everyone was upside down. He managed to undo his seat belt and feel for the emergency door handle cover, which he pulled off and rotated the handle to open the door and then proceeded to the surface.

On reaching the surface he noticed Harold Pennison, the pilot and the Nigerian Mr. Hope came to the surface one after the other. They all clambered on to the floats until the divers arrived.

A rubber dingy from the mother ship KRANTOR approached about 15 minutes after the accident. An helicopter which, might have picked the 'MAY DAY' transmission had hovered and left about 5 minutes after the accident.

1.17.2 SURVIVOR NO. 2

Mr. H. P. Pennison is 63 years old, on contract with the on-the-job training programme of Oil Well Producing Operations of Mobil Produce (Nig.) Ltd. He was returning from the Off-shore platform of QIT from Asabo going to Eket. He gave evidence that there was a surge as if there was a bad weather. 'The helicopter twisted and dipped slightly then more abruptly. It levelled off again. When we hit water, we were still moving forward quite fast. ¯The ¯helicopter filled with water immediately". He said he located the emergency door handle and opened it then got out of the helicopter. Ron Armstrong was the next one out, then the Bristow Captain and then one Nigerian.

Mr. Pennison, on interview, gave evidence further that he had the impression they were going to crash looking at.fast rate of losing altitude and from the slanting angle he was observing the BOP platform on which they were supposed to land. The platform looked slanting from his position of view.

Mr.. Pennison said that he was used to hearing helicopter engine pitch change and the rotor sound change when flaring for touchdown, but this one neither changed engine pitch sound, nor the rotor sound. It maintained the nose down approach till the nose hit water and

the aircraft turned over. No time elapse between the impact with water and when the helicopter cabin got filled up with water. He said he did not feel any tremendous impact when the helicopter hit water and he guessed it was because the 'copter hit water with the nose side first. Mr. Pennison said that his he was sitting was the BOP platform and everything looked crooked to him and they went straight down into water just like that. On surfacing, the pilot said he lost tail rotor; ''but I looked at the back and saw the tail rotor still on".

1.17.3 SURVIVOR NO. 3

The Inspector of Accidents could not conduct any interview with Mr. Hope Enaibre, who had travelled to Port Harcourt after the accident; but his hand written report was passed to the inspector.

Mr. Enaibre wrote that, himself, Archibong Nsikak and Roman were picked up by the helicopter at Adua and were going to QIT. Close to SOP the helicopter dived; the pilot controlled it and put it back to normal flying position. Later the chopper turned upside down and fell into the sea.

He wrote he was sitting at the extreme outside seat (Appendix 1) (left side position No. 13) with expertrates seating at the two back seats (well-seats position 11 & 12). He also wrote that the helicopter over turned" and everybody seating in the chopper fell on me". He managed to get himself off from his seat and turned back towards the other door. He hit the door in order to break the glass but the glass did not break. Then he turned back and saw an opening and got himself out through the opening. He met the two white men already atop

The last surviving soul on board was the pilot-in-command who gave evidence that after hearing of the bang sound from the engine followed by the jaw to the right accompanied by a sharp pitch down, he quickly took over the control and started to put in corrective measures for a loss of the tail rotor, which he thought was the problem. He said that by the time the aircraft had nearly reached the sea, he raised up the nose, speed around ''70 knots, he then started to reduce the speed and rate of descent, at the same time he gently increased power until the aircraft was flying at about 20 feet and 40 knots in a gentle descent into the sea. He said that he then gently flared off the speed lowering the lever as he did so to prevent yaw to the right. After the 'May Day', he said he told his First Officer that he, the captain, proposed to ditch. He said that the aircraft slowed down and he told his First Officer as he flared that he would close the throttles as soon as the aircraft started to yaw. "Now ground speed was about 5 knots and about 4 feet above the surface, 1 closed the` throttle and the aircraft landed quite heavily onto the sea with a side ways component due to 30 - 40^0 of yaw", thus he concluded his, story.

AN EYEWITNESS

Mr. Celestine Effiong is a Nigerian male of about 45 Years of age. He is a contractor performing choke Inspection on the BOP platform.

Mr Effiong gave evidence that not far from his position,he could see the helicopter approaching from the western Area of the sea towards BOP.It came in a landing manner and the landing light was on for about two minutes,he was observing the behavior of the helicopter and he started shouting to other people to come and see how the chopper was about to land on water. He said that the chopper was trying to keep flying but could not and then dropped into the water almost with nose first without wasting time. Just as the aircraft touched water he left for the radio room to call on the radio that an helicopter had crashed. On coming back out he then saw 3 or 4 heads of people who were hanging on to the floats. Then the 2 big boats, the KRANTOR and the ROYAL SERVICES were approaching the aircraft.

ANALYSIS

2

Duty Period

On the day prior to the day of the accident the Co-pilot had a three hour duty period i.e. 1440 hours to 1740 hours and resumed duty on the day of the accident at 1200 hours. The commander had the first tasking of the day while the co-pilot had the second tasking covering 1435 hours to 1550 hours. The third tasking was shared between the two pilots and the second-in-command took over the last half from ASABO for the homeward journey with 2 stops in between. ASABO to BOP, (which was the next port of call since taking over the control is only 12 minutes or 20 nautical miles).

At the beginning of February, the copilot flew for the 1st four days of the month and had the time off only to resume on the 14th; though flying everyday since resumption partly on the controls and partly as co-pilot splitting the flying time 15 and 16 hours respectively; all were daytime flights. The Accident Investigation Bureau does not consider this flying duty as over stressing for the relatively new but young pilot on rotary wing machine. The co-pilot must have enjoyed his flying experience with different captains and the accident trip was the first experience with this commander. Investigation also reveals that there was no known discordiality between the crew before or during the flight

2.2 THE MAIN ROTOR

Many possibilities were considered for the-cause, or what might have caused the "bang" noise and the initial uncontrollability that followed the bang sound.

The main rotor was observed for preimpact and post impact damages; it was found out that ore rotor blade, surely the first blade to hit water, had its face over turned, i.e the top side was flipped over, now facing downward. Owing to the impact, the pitch horn lugs were pulled out from the attachment point, and a control tube was fractured by a compressional force, which might have occurred when the rotor blade, still under engine power, hit the water with the aircraft's forward motion. This may confirm the nose first attitude of the aircraft at impact.

The relatively high forward motion of the aircraft coupled with the tip of the main rotor blade now dipping into the water at the beginning of the impact must have met with an enormous water resistance which subjected the Control tube to a high compressional overload and fractured the tube.

The rear down-ward whiplash of the disabled rotor must have strickened the left elevator and fractured its spar tube structure.

2.3 THE TAIL ROTOR

Failure of the tail rotor and its control mechanism were examined during the initial investigations. After it had been determined that there was no pre-impact failure to the main rotor; then, the tail drive shaft was disassembled and carefully inspected and there was no evidence of any failure to the tail rotor control nor its drive mechanism. So the tail rotor did not fail as assumed by the captain before he started to put in corrective actions of a tail rotor failure diagnosis. The corrective input was totally an over-reaction in the wrong direction.

2.4 OPERATIONS (Human Factors)

This Bureau believes that the crew actually heard a "bang" noise coming somewhere from the helicopter; and that the right yaw was associated with the bang noise. But we disagree with some opinions presented during the preliminary investigation that the noise heard could be attributed to a fallen unrestrained tool box within the cargo compartment of the aircraft. If the fallen tool-box made the sound, it cannot definitely, rock the ship to the magnitude of about 40° yaw, not even slightly to the right according to the commander's account. But this Bureau believes and propounds that the bang could be attributed to a sound coming from or be associated with a compressor surge; or a compressor stall which could also be accompanied by a yaw.

what could cause the surge or the stall is when the compressor Bleed Valve refuses to relief an excessive pressure build-up in the gas generator chamber of the engine. The Bleed Valve with the problem of rolled-up diaphragm could give this Symptom, if in an attempt to

open and dump some built-up pressure but could not open up.fully.. This was the position that the diaphragm of one of the Bleed Valves was found - The piston attached to the diaphragm could neither fully travel up nor down, because the diaphragm had rolled-up and was pinching between the piston and the valve wall. The applied lubricating grease had become gummy and sticky, thereby preventing free movement.of the.diaphragm.

The facts are, there was a bang noise and there was a yaw which necessitated a corrective measure. More appropriate to the rotary wing than the fixed wing is the fact that any type of emergency can lead to disaster if the corresponding and appropriate actions are not taken. There are emergencies which require precautionary landings, we believe that the situation on hand only required a precautionary landing if the crew's experience with Bell-212 had been adequate and profound enough.

The emergency procedures in the Bell 212 "Operations Manual" give indications of "Tail Rotor Drive Failure" as:

"Uncontrollable right yaw and lack of response to pedal movement"

Actions:

1.	COLLECTIVE	Enter full autororation
2.	AIRSPEED	Reduce to 65 - 70 knots
3.	RADIO/TRANSPONDER	Transmit distress/squawk 7700
4.	PASSENGERS	Warns, Life Jackets and seatbelts.
5.	COLLECTIVE/AIRSPEED	Attempt to find power/speed combination for level flight.

If unsuccessful:

6.	FLOATATION	ARM
7.	THROTTLES	Close fully
8.	DITCH	or land

But how did the crew accomplished this laid down procedure, or reacted to the emergency 7 To find the answer, the Bureau went back to review the evidence given by the captain to see his reactions to the situation.

The aircraft was cruising at 700 feet with the airspeed indicating 70 knots.

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2. **Heard** the bang accompanied by a sharp yaw to the right and a sharp pitch down.

3. Captain took over the control and thought initially that the aircraft was uncontrollable.

4. Lowered the lever and entered autororation; 3 or seconds later, control responses became normal.

5. Captain diagnosed tail rotor failure and broadcas "May Day"

6. By this time, the aircraft had reached the sea.

7. Raised up nose; speed around 70 knots; started tc reduce speed and rate of descent; at the same time gently increased power until the aircraft was about 20 feet and 40 knots; a gentle flare to reduce speed; and preventing yaw to the right.

We believe that the crew heard a bang and the aircraft had a yaw which made the commander to take over the controls; but the commander misjudged that the helicopter had a tail rotor problem. The captain had over-reacted by not properly isolating the type of the problem before applying corrective measure of a tail rotor drive failure. If he had diagnosed properly, the commander would have observed that response to pedal movement, which was skill available to him, would have nullified the wrong diagnosis of a tail rotor failure.

We also believe that the commander did not manage the collective /airspeed well enough in an attempt to find power and speed *combination* to *maintain* a level flight as advised by his flight manual.

Instead of trying to *maintain* a level flight, the captain dived the helicopter straight down into the water. For about 3 or 4 seconds, according to his own given evidence, the control responses became normal, the captain could still not recognize that the problem was not that of tail rotor failure; he should have, within this period, begun to execute the requirements for precautionary *landing and* not *an* emergency landing

Even as a counter-measure for a tail rotor failure, pilots are advised to "fully close" the throttles before ditching but this commander ditched the aircraft with the number one throttle in flight idle position and only that of number two engine was in a shut down position.

2.5 INITIAL INJURY TO THE CO-PILOT

The tremendous impact with water shattered the lower nose section window transparent acrylic plastic (plexi-glass) on the co-pilot's side and the splinters were propelled by the inrushing water cascade direct into the First Officer's face and chest. These column of water and the splinters might have knocked the co-pilot unconscious. The corpse's face bore scars relative to type of injury from flying debris. He was known to be a good swimmer yet he could not unstrap his seat belt and shoulder harness. The divers recovered the body still strapped to its seat. The force of the inrushing water through the broken window was so tremendous that it sheared off 3 out of 4 rivets, which were attaching the pilot's left foot plate to the airframe structure. (please see appendix 11).
The Seaweld divers from the rescue ship KRANTOR, gave witness that all of the bodies recovered from the main cabin were floating because
the passengers did not use the seat belts. Only one soul out of nine in the cabin survived the tragedy. It is pertinent to mention that most of the off-shore helicopter operation passengers are people with little or no aviation experience and whom the flight crew pay little or no attention
to their observance of safety regulations when on-board the aircraft.

None of them would have successfully operated the emergency panel door opening handles, even if they had been sitting in an up-right position under an emergency situation. The only surviving passenger among this cadre was dashing from one side door to the other looking for an escape route before he could observe an opening through which the wellseat occupants - the two expertrates had escaped. The expertrates, though managed to open the emergency door, but not without hardship of locating the tiny finger hole to gain access to the emergency door handle, (Appendix 15). Mr. Hope Enaibre probably owes his survival feat to his own swimming ability.

2.6 EMERGENCY EXIT DOORS

The Flight Manual states that the floatation gear must not be inflated manually with the aircraft in forward speed. So, the gear switch is always selected in the ARM position when flying over water. At the time of the accident, 5N-AJY came in contact with the sea in a nose pitch down attitude then the liquid sensitive trigger devices

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3.-1.1 The helicopter was certified in accordance with the Civil Aviation Regulations.

of, **the floatation** gear became energised and **inflated the** floats, which in our opinion, contributed to overturning the fuselage instead of settling it on surface of the water. The floats **now suspend the helicopter** upside down like a pendulum.

All the passengers in the main cabin were shifted to the left side of the cabin, all piling over the survivor No. 3, who managed to extricate himself and swim to the starboard cabin door but did not try to unlock the emergency door before dashing back to the rear portboard emergency door through which survivor Nos.1 and 2 had escaped.

The rear portboard emergency escape panel was operated by the two side facing expertrate passengers (survivor Nos 1 & 2). Locating the position of the emergency panel handle temporarily presented a problem for the expertrates,how much less the low educated shophands who were disoriented under water. The tiny finger hole access to the emergency panel handle could only be located by feel of the hand and are therefore, not congenial to the ability of the type of the people who mostly use this aircraft. This type_ of emergency exit opening mechanism must be improved on or changed.

The starboard-side-facing rear-seats were unoccupied because they served as cargo hold together with the tool-box which some opinions expressed might have given the bang sound when it fell from the seat or somewhere within that department. But the Bureau believes that the fallen tool-box would not make the aircraft yaw to the right, and it is also not heavy enough to give a loud bang over the engine and rotor noises within the inside of the aircraft

Although the surviving pilot gave an evidence of a well ochestrated and well rehearsed flaring profile preceeding the ditching story, this Bureau believes that the captain did not have that elusive time to brief and prepare his co-pilot for the imminent ditching and in fact, he also gave evidence that he did not have the time to warn his passengers on any safety procedure of over water emergency landing. All evidence, as given by the surviving passengers and the platform observer, pointed to the fact that the commander did not have the time nor the ability to achieve a perfect ditching like he would want the Bureau to believe and this is the crux of any emergency or cautionary landing. As it all turned out, the helicopter had a considerable amount of forward speed when it impacted the nose section with water. The magnitude of the impact velocity and the banking attitude of the aircraft were corroborated by the amount of impact damages to the nose honey-comb section on the co-pilot's side.

3-1.2 The flight crew was also certified and qualified to fly the helicopter. The crew members had their maximum rest period before under-taking the flight.

3.1.3 The aircraft had an impeccable record of maintenance history.

3.1.4 The compressor Bleed valve serial number A29206 had its diaphragm replaced sometime in early 1990 but installed on the aircraft on the 12th October 1990.

3.1.5 The Time Since Overhaul (TSO) of the Bleed valve at installation was 3224 hours 40 minutes at the airframe time of 21123:40 hours, having run for 757:20 hours when the aircraft crashed at 21,881 hours. The TSO of the Valve was therefore 3,982 hour of the time of the accident.

3.1.6 The TSO of the Bleed Valve serial number 44316 on the No. 2 engine was 283:48 hours; installed on the aircraft at the airframe time of 18779:20 hours having run for 3,101:40 hours when the aircraft crashed at 21,881 hours. The TSO of the valve was therefore 3,101:40 hours at the time of the accident.

3.1.7 Bleed Valve Serial Number A4316 on the No.2 engine was found to have its diaphragm rolled up and kinked, therefore not permitting full up and down travel motions of its piston.

This malfunction could have caused the problem of compressor surge resulting to the type of bang sound that the captain claimed he heard.

3.1.8 This surge or sound could have not adversely affected the aircraft's performance from sustaining the continuation of the flight before ditching.

Bleed Valve Serial Number A29206, which had its diaphragm replaced and purportedly had its cover replaced in 180° out of phase had run for 758 hours and could have not caused such a problem as to have incapacitated the aircraft.

The co-pilot was flying the aircraft when the bang sound was heard followed by the aircraft's yaw to the right and the captain quickly took over the control.

From the situation on hand, the commander diagnosed a tail rotor failure recovery procedure.

The captain controlled the aircraft in a nose-down pitch and left banking attitude which the aircraft did not recover from (cause factor).

From the impact evidence, the nose section absorbed most of the impact force, which crushed a substantial area of the fibre glass material and shattered the chin window on the co-pilot's side.

The shattered acrilytic transparent plastic window splinters with the cascade of water forced through the chin windo~; by the momentum of the diving aircraft, shot straight onto the face and chest of the co-pilot, knocking him momentarily out of consciousness from which he did not recover and resulted into his asphyxiation (fatality factor).
The floating gear, which had been previously in the ARM position was inflated on contacting with water and over-turned the helicopter.

Most of the passengers did not fasten their seat belts as of the time of the ditching. (fatality factor).

The emergency door opening mechanism is not designed to the congeniality of most passengers′ who predominantly use the aircraft.

CAUSE OF ACCIDENT

The probable cause of the accident is operational handling of the aircraft during the ditching period.
The arising situation required a cautionary landing rather than an emergency landing.

The contributory factor to-the calamity is the passengers' not fully prepared for over water survival practices.

4 SAFETY RECOMMENDATIONS

Oil Companies operating off-shore rigs and aircraft operators must intensify their efforts of inculcating safety and survival aptitudes of the local helicopter passengers. The presently employed verbal advisory briefings will no longer suffice; Practical Survival *trainings* like submerging a dummy helicopter capsules in a specially constructed swimming pool is suggested mandatory for frequent helicopter passengers.

4.2 The emergency door opening mechanism of off-shore helicopters must be redesigned to have a quick action *opening* capability and yet have a fool proof device for unintentional openings.

4.3 Nigerian registered helicopters certificated for a 2 man crew operation must be' installed with a cockpit voice recorder (CVR).

4.4 Bristow Helicopter (Nig.) Ltd to incorporate the Auto/Manual fuel switch guard modification in compliance with MOD/212/3027 directives.

5 APPENDICES

5.1 Sitting Configuration of 5N-AJY during the time of the accident.

5.2A Exploded view of the Compressor bleed valve

5.2B Photographs showing the damaged Bleed Valve diaphragm on the left hand in comparison with a normal one on the right hand.

5.3 Engine No. 1 bleed valve's test bench result and the analysis after disassembly.

5.4 Engine No. 2 bleed valve's test bench result and analysis.

5.5 Test bench result of the No. 1 engine's automatic fuel control unit.

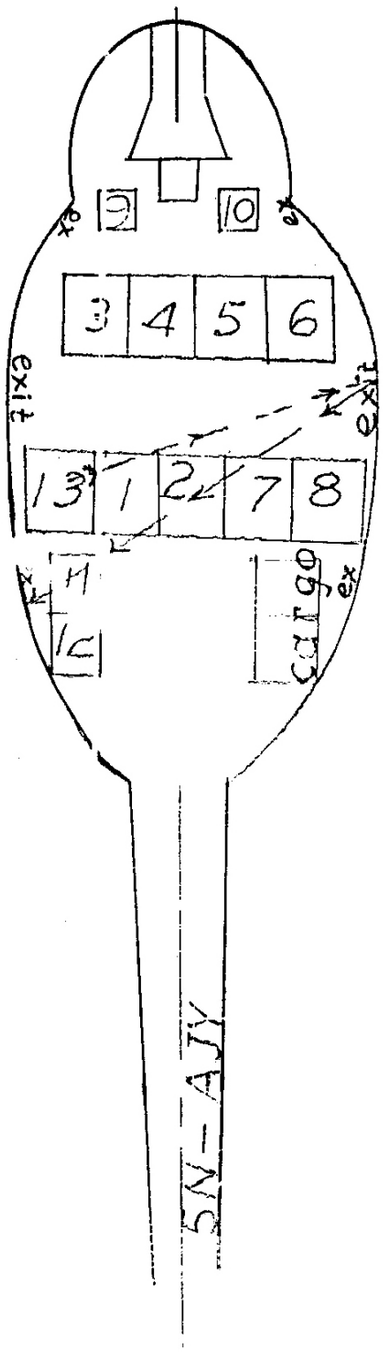
5.6 Test bench result of the No. 1 engine's manual fuel Control Unit.

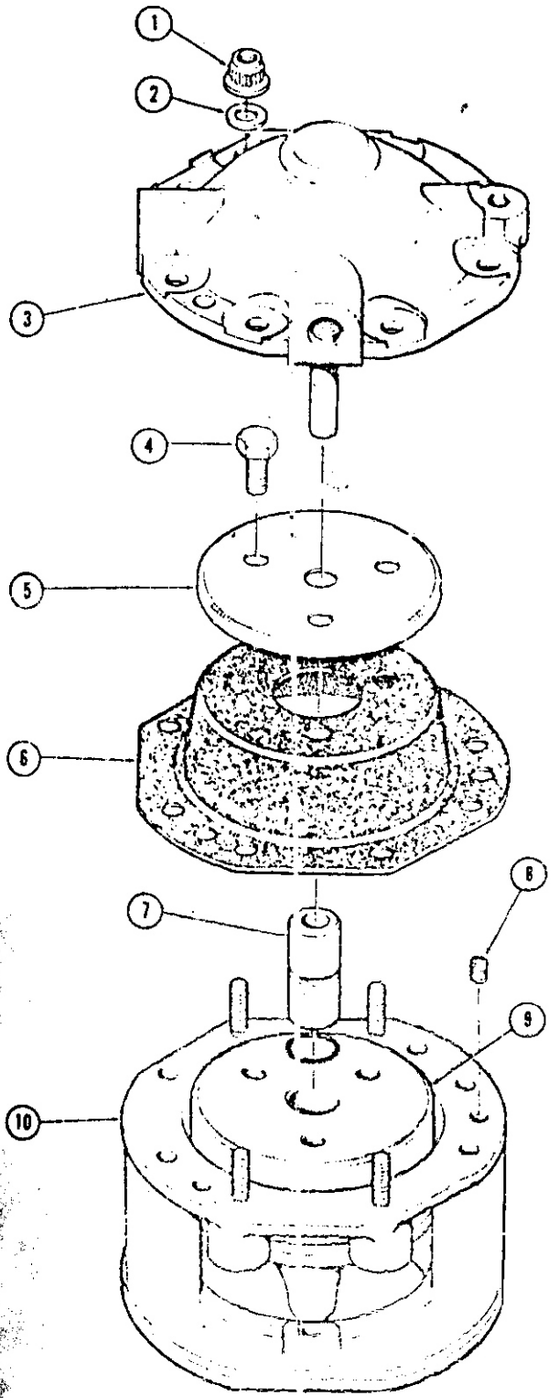
5.7 Test bench result of the No. 2 engine's Power Turbine.

5.8 Test bench result of the No. 1 engine's Power Turbine Governor.

5.9 Appendices 5.9 through 5.15 show the tell-tale pictures of damages to the aircraft.

Sitting Configuration of AJY According to the lists A & B
On Page 3 of this report

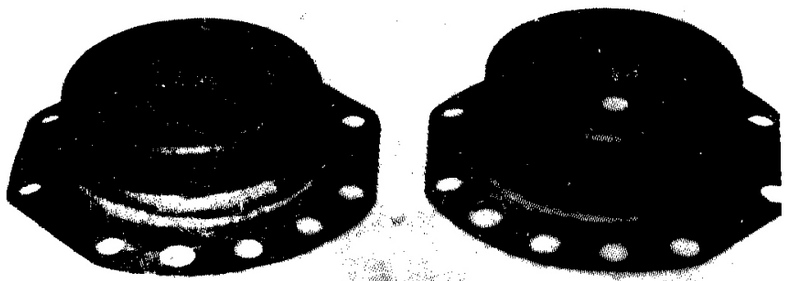




APPENDIX

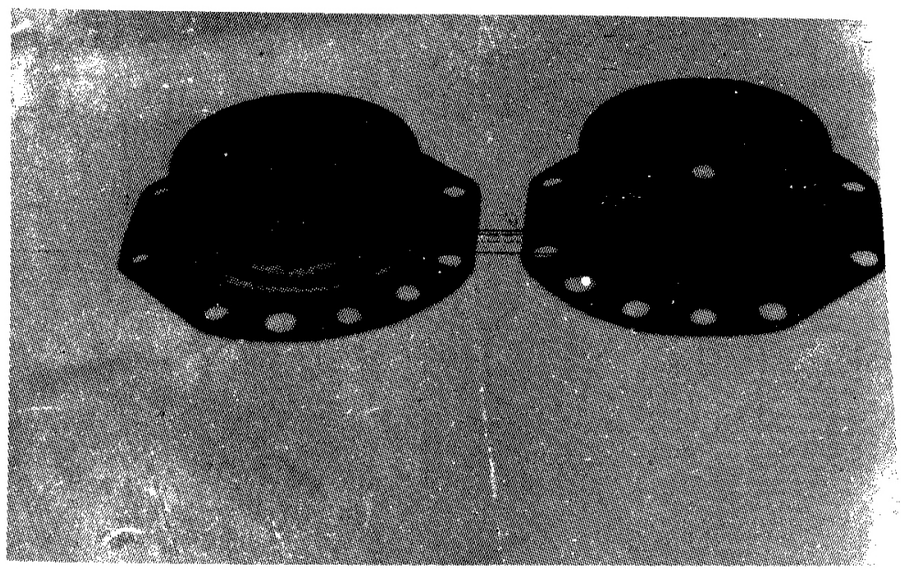
1. Self-locking Nu
2. Washer
3. Cover
4. Bolt
5. Retaining Plate
6. Diaphragm
7. Spacer Sleeve
8. Primary Meterir Plug
9. Piston
10. Housing

Compressor Bleed Valve Diaphragm Replacement
Figure 203



APPENDIX 2B A

The pinched diaphragm on the left - In comparison with a normal one on the right.



B

Another angle of the damaged diaphragm.

APPENDIX 3

REC # TR 7100 — PRATT & WHITNEY AIRCRAFT OF CANADA LIMITED — W/O ______

ENGINE ACCESSORY TEST RECORD

REV. AUG 1990 — UNIT: PT6 Bleed Valve — UNIT S/N: A29206

PAGE 1 OF 1 — UNIT P/N: 3033063 — ENG. S/N: 30631

MAN P/N: 3017043 — CUSTOMER: ______

MAN REV: ______ TESTED BY: Mario Valleranc — TEST DATE: 22 MARCH 91

MAN REF: ______ FINAL ACCEPTANCE (STAMP) — ACCEPT DATE: ______

1.0 REFERENCE CONDITION

Ambient Temp.: —; Barometric Pressure: —;

Correction for Temp.: —; Corrected Barometric Pressure: 30.18

Delivery Pressure: 55 PSIA; Potentiometric Pressure (Px): Min: 20.00 Max: 20.30

2.0 LEAKAGE TEST

Leakage Tested 55 PS psia for 5 min. Actual leakage HEAVY LEAK max. permissible 5.0

3.0 CALIBRATION CHECK

Barometric Pressure (Pa) in. Hg	(psia)	Potentiometric Pressure (Px) Actual (psia)
30.6	15.03	( )
30.4	14.93	( )
30.2	14.83	→ (14.9)
30.0	14.73	( )
29.8	14.63	( )
29.6	14.54	( )
29.4	14.44	( )
29.2	14.34	( )
29.0	14.24	( )
28.8	14.15	( )
28.6	14.05	( )
28.4	13.95	( )
28.2	13.85	( )
28.0	13.75	( )

[Handwritten margin note:] LEAKAGE FOUND BETWEEN SLEEVE AND HOUSING

REMARK: Bowl cover installed 180° from required position. Px Pressure is very low (14.9 psia)

4.0 ASSEMBLY

Primary orifice: Tightening torque 10 - 15 lb. in.
Secondary orifice: Tightening torque 35 - 40 lb. in.
B.O.V. Class (20).
NOTE: For B.O.V. P/N 3100829-05 and -06, prior to the leakage test, remove the primary orifice and using a suitable 10-32 thread bolt, confirm that a total of at least 8 full turns can be achieved, to allow proper installation of the primary bleed.

REC # TR 7100 — PRATT & WHITNEY AIRCRAFT OF CANADA LIMITED — W/O

REV. AUG 1990 — ENGINE ACCESSORY TEST RECORD — UNIT S/N: A 4316

PAGE 1 OF 1 — UNIT: PT6 Bleed Valve — ENG. S/N:

MAN P/N: 3017043 — UNIT P/N: 3033053 — CUSTOMER:

MAN REV: — TESTED BY: Dave Vallard — TEST DATE: 22 MARCH 91

MAN REF: — FINAL ACCEPTANCE (STAMP) — ACCEPT DATE:

1.0 REFERENCE CONDITION

Ambient Temp.: —; Barometric Pressure: —;

Correction for Temp.: —; Corrected Barometric Pressure: 30.18

Delivery Pressure: 55 PSIA; Potentiometric Pressure (Px): Min: 17.60 Max: 17.

2.0 LEAKAGE TEST

Leakage Tested 55±5 psi or 5 min. Actual leakage 0.2 max. permissible 5.0

3.0 CALIBRATION CHECK

Barometric Pressure (Pa)		Potentiometric Pressure (Px)	
in. Hg	(psia)	Actual	(psia)
30.6	15.03		( )
30.4	14.93		( )
30.2	14.83	→	(17.55)
30.0	14.73		( )
29.8	14.63		( )
29.6	14.54		( )
29.4	14.44		( )
29.2	14.34		( )
29.0	14.24		( )
28.8	14.15		( )
28.6	14.05		( )
28.4	13.95		( )
28.2	13.85		( )
28.0	13.75		( )

PISTON NOT MOVE FULLY

REMARK:

4.0 ASSEMBLY

Primary orifice: Tightening torque 10 - 15 lb. in.
Secondary orifice: Tightening torque 35 - 40 lb. in.
B.O.V. Class (2).
NOTE: For B.O.V. P/N 3100829-05 and -06, prior to the leakage test, remove the primary ofifice and using a suitable 10-32 thread bolt, confirm that a total of at least 8 full turns can be achieved, to allow proper installation of the primary bleed.

FUEL ACCUMULATOR (TRIM) ACCEPT DATE:

*,Recheck test point after adjustment and proper torquing.
Pc-Py, P1-P2, Pr-Pa, Pg-Pa, and Pg-Ps pressure units are inches Hg.

TEST POINT	SPEED RPM	Wf1	THROT ANGLE	Pc PSIA	Po PSIG	Wfn MIN	Wfn	Wfn MAX	MISCELLANEOUS	NOTES
Linearity And Bypass Valve Setting										
SEQ.	2	3-6	1	4	5					
*1.01	5800	1350	MAX	40	195	[233]	242	[242]	P1-P2(28)[26 - 38] Pn(26.2)	
*1.02	2900	720	30-32	40	85	[76]	75	[79]	P1-P2(28.0) Pn(19)	
*1.03	5800	1350	MAX	70	150	[410]	426	[430]	P1-P2(28)[26 - 38] Pn(9.35) Pc-Py(.20)[6.5 max]	
*1.04	5800	1350	MAX	100	105	[565]	575	[575]	P1-P2(28)	
1.05	5800	1350	MAX	40	195	[-10]	22	[+10]	P1-P2(28)	1
2.00	Speed Enrichment - Deleted									
Governor Spring Setting										
SEQ.	4	3-7	1	2-6	5					
*3.01	6550 6450	1440	90	85	180	[445]	445	[455]	450 — Hysteresis in Stiff Flyweight action: Also Sticky	
3.02	( )	1440	90	85	180		450		FLOW COMEBACK ALONE TO 450 PPH	
3.03	6600	1530	90	85	260	[295]	400	[315]	Bleed(1)K)[63 - 68]	
3.04	( )	1440	90	85	180		450		Speed dif.( )	2
Ground Idle And Flight Idle Adjustments										
SEQ.	3	1-7	4	2-5	6					
*4.01	3300	800	28-30	30	90	[104]	75	[112]		
SEQ.	2	1		3	4		5			
4.02	4000	1000		27	140		87.5		Throt. Angle(40°)[39 - 42°]	
Low End Accelleration And Throttle Movement Effect										
SEQ.	2	4	3	1	5					
5.01	815	200	40	Amb	45	[60]	28			
5.02	2100		40	25	50	[134]	136	[150]	W_{fn} dec.(0)	3

REC # TR 1686

REV. 11 Sept. 1987

PAGE 1 OF 1

MAN P/N: 3020529/BENDIX 73-70-02

MAN DATE: 20 Nov. 1984

TABLE: 702

PRATT & WHITNEY AIRCRAFT OF CANADA LIMITED
ENGINE ACCESSORY TEST RECORD

W/O

UNIT: Manual Fuel Control

UNIT P/N: 2524998-12 and up

TESTED BY:

FINAL ACCEPTANCE (STAMP)

UNIT S/N: A15289

ENG. S/N: 60481

CUSTOMER:

TEST DATE: 6-25/may

ACCEPT DATE:

TEST POINT	VOLTS dc	F_{ti} pph	Po PSIG	THROT ANGLE	F_{tn} MIN	F_{tn} MAX	MISCELLANEOUS	NOTES
1	0	200/275		90			P1-Po(_____)[1010-1070]	
2	24	(_____)		90			P1-Po(_____)[55 - 68]	
3	24	800		(_____)				
4	24	800		0			Leakage(_____)[2cc/Min max]	
5	24	720	65	25	[85](_____)[90]		P1(_____)	
6	24	20	65	25	[70](_____)[90]			
7	24	720	65	40	[85](_____)[95]			
8	24	0	65	50	[130](_____)[140]			
9	24	1350	15	(_____)	[520](_____)[540]		P1-P2(_____)[26-38 in. Hg.]	2
9A	24	1500	20	(_____)	[565](_____)			3
10	0	720		25			P1(_____)	
11	24	720	65	25	[85](_____)[90]			
12	0	720		25			P1-P2(_____)[0 in. Hg.]	
13	14	720		25	[85](_____)[90]			
14	0	720		25			P1-P2(_____)[0 in. Hg.]	
15	30	720		25	[65](_____)[90]			
16	0	720		25			P1-P2(_____)[0 in. Hg.]	

Verify check valve for proper installation STAMP _____

NOTES:

1. Record cut-off angle of throttle shaft (9 to 12 degrees).
2. Record throttle angle (89 to 91 degrees).
3. Record throttle angle (94 to 96 degrees).

SYMBOLS:

F_{ti}: Inlet fuel flow (pph).
F_{tn}: Nozzle fuel flow (pph)

SOLENOID TEST P/N 184345

TEST POINT	INLET PRESSURE	OUTLET PRESSURE	FLOW
1	101	65	(_____) [82.5 min]
2	115	65	(_____) [97.0 min]
3	205	105	(_____) [137.0 min]
4	505	105	(_____) [275.0 min]

TA 5020	POWERPLANT OVERHAUL INSPECTION RECORD. PAWC 1378 (4-79)	W/O
Rev. Date 27 April 1979		ENG S/N 60752
PAGE 1 OF 1		P/N 2524999-4
CUSTOMER BRISTOW UK / ALGERIA	POWER TURBINE GOVERNOR P/N 2524999-1 thru-4	UNIT S/N A9585
		TSN
		TSO

TEST AS RECEIVED

TEST POINT	SPEED RPM	Pr-Pe INCHES Hg.	THROTTLE ANGLE	Pr-Pe Inches Hg.		
				MIN.	RECIED	MAX.
1	3900	34.3	85	0.0	0	0.6
2	3900	34.3	85	2.5	2.6	2.7
3	~~4500~~ 4,223	34.3	15	6.8	7.3	7.8
4	~~4550~~ 4,405	34.3	5	———	14.5	———
5	4,210	34.3	75	———	7.3	———
6	4050	34.3	65	4.5	7.9	7.5

NOTES: 1. Pr-Pe pressure, T.P. 3 and T.P. 4 difference 6.5 to 8.0 inches mercury. 7.2 INCH OF Hg

2. Speed at T.P. 5 must be within 40 rpm of T.P. 3 speed. Approach from 4550 rpm. -13 RPM

REMARKS:

TP6 4,050 65° - 9.9

3,952 65° - 6.0

4,050 70° - 6.0

DATE 12 MAR 1991 AUTHORIZED [signature] 78 INSPECTOR

ERROR: ioerror
OFFENDING COMMAND: image

STACK: