Federal Ministry of Aviation



Tel: 5238568

Accident Investigation and Prevention Bureau

FEOEPAL SECRETARIAT, SHERIU SHAQARI WAA ARHTA

Ref. No FMA/AIPB/382/240 25 November 20 02

The Honourable Minister, Federal Ministry of Aviation, Federal Secretariat Complex, Shehu Shagari Way, P.M.B 5012, Wuse, Abuja.

Honorable Minister Ma'm,

CIVIL AVIATION ACCIDENT REPORT No. 382

I have the honour to present the final report on the accident to the Executive Airlines Services' BACI-II-525FT aircraft registered 5N-ESF that erashed at Mallam Aminu Kano International Airport (MAKIA), Kano State on Saturday, 4th May 2002.

R. FAMINU, Ag. D (AIPB)

بده

FMA/HM/PRES/007/S.1/XI

Chief Olusegun Obasanjo, GCFR President, Federal Republic of Nigeria, Aso Rock Villa, Abuja.

REPORT ON THE ACCIDENT TO THE EAS BAC 1-11-525 AIRCRAFT AT MALLAM AMINU KANO INTERNATIONAL AIRPORT, KANO

I wish to most respectfully forward to Your Excellency, report on the accident which occurred at the Mallam Aminu Kano International Airport on May 4^{th} 2002. The accident involved an EAS BAC 1-11-525 aircraft. The report is just coming in inspite of the pressure I put on the relevant bodies to submit the report early. A draft acknowledgement statement has also been prepared at page two of the report.

- 2. Your Excellency, I wish to state that certain actions have been taken to avoid re-occurrence of such accidents especially with the implementation of the relevant provisions of the Reviewed Nigerian Civil Aviation Policy.
- 3. Finally, may I use this opportunity once again, to thank Mr. President and the Nigerian public for their support during the period of the accident and after. On behalf of the entire aviation family, I wish also to condole the families of those who lost their loved ones in the tragic aircraft accident.
- 4. I thank Mr. President for your continued understanding of matters affecting my Ministry, while awaiting your further directives.

Dr. (Mrs.) Kema Chikwe Honourable Minister

ACKNOWLEDGEMENT

20.4

BY THE PRESIDENT OF THE FEDERAL REPUBLIC OF NIGERIA.

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SYNOPSIS

The BAC1-11-525F aircraft was operated by a Nigerian registered operator, in the Transport Passenger Category under the registration mark 5N-ESF. The aircraft was constructed in November 1980 and had accumulated a total operating flying time of 24,644hours and 34 minutes.

On Saturday 4th May 2002 the aircraft was operated out of Lagos at 0901 hours UTC to Jos - duration of 1 hour and 18 minutes. It departed Jos at 1107 hours for Kano, a flight of 33 minutes duration. The aircraft taxied out of Kano ramp at 1222 hours and lined up at the threshold of runway 05/23 waiting for the controller's takeoff clearance, which was given at 1229 hours.

Apparently, runway 05/23 is 2,600 metres long, but shorter than any other runway around and was the runway currently in use, because of the recent NOTAM, which closed the normal runway 06/24 to traffic for resurfacing. The takeoff roll was commenced at 1230 hours and the aircraft over-ran the end of the runway by several metres before airborne, but could not climb faster enough until it made impacts with several buildings on the takeoff path. 73 souls out of 77 on board suffered mortal injuries, while 30 people on ground died and several suffered serious injuries. AIPB discovered that the accident was totally avoidable, if the crew had made proper planning and astute judgment.

FINAL REPORT ON THE ACCIDENT TO THE EXECUTIVE AIRLINES SERVICES LTD'S BAC-1-11-525 AIRCRAFT REGISTERED 5N-ESF AT MALLAM AMINU KANO INTERNATIONAL AIRPORT, KANO STATE ON SATURDAY, 4TH MAY 2002.

AIRCRAFT DATA

Type: - BAC-1-11-525FT

Model - 525FT.

Serial Number: - VH/266.

Registration Number: - 5N-ESF

Manufacturer - British Aerospace Airbus Ltd

New Filton House, Filton, Bristol, U.K.

Date of Construction - 13th November 1980

Airframe Total Time - 24,644hrs: 34mins

Airframe Total Cycles - 16.844

'C of A' Validity - 1st August 2002

Previous Owner/Operator - TAROM S.A.

Otopeni Airport Bucharest, Rumania

Owner - Premi Air Charter

Dublin, UK

Operator - Executive Airlines Services Ltd. (EAS)

29, Adeniyi-Jones Street,

Ikeja, Lagos State.

ENGINE

Type - Rolls Royce Spey
Model - 512-14 DWE

Position No.1 No.2
Serial Number - 7901 7114

Total Time - 16,989 Hours 10,535 Hours

Total Cycles - 6,169 6,667

Commander

Peter Abayomi Inneh Name 49 Years (14 April 1953)

Age.

Nigerian Nationality ATPL #2089 Licence No. 16th July 2002 Validity 14.200+ Hours **Total Flying Hours**

Approximately 7,000hrs Hours on Type

Caravelle SE-210, Aircraft Rating

BAC 1-11, Boeing-727

First Officer

Chris Adewole Adeboye Name

47 Years (21 November 1954) Age

Nigerian Nationality ATPL #3209 License No.

6th September 2002 Validity of the Licence

8.030 hours **Total Flying Hours** 3,350 hours Hours on Type BAC 1-11, Aircraft Ratings Cessna-402.

Mallam Aminu Kano International Airport Place of Accident

1,565 feet (above sea level) Airport Elevation 2,600metres (8,530 feet) Runway Length

12° 02' 57"N. Geo. Coordinates 008° 31′ 30"E.

4th May 2002 Date of Accident

1230Hours UTC. (1:30PM)Time of Accident

77 Souls-On-Board

1.0 FACTUAL INFORMATION

1.1 History of the Flight

On the day of the accident, 4th May 2002, 5N-ESF departed Lagos at 0901 hours UTC with 101 passengers on board and was operating the company's revenue flight number EXW 4227 to Jos. The aircraft landed in Jos at the time 1019hours UTC and a number of 65 passengers disembarked, leaving 36 Kano bound passengers on board. Another 47 Lagos/Kano bound passengers boarded the aircraft for Lagos enroute Kano. Takeoff from Jos was chock off at 1100 and was airborne at 1107hours UTC with 90 souls (crew + passengers) on The aircraft landed in Kano at 1140hours and remained on ground for about 50 minutes with 47 Lagos bound passengers in Another 22 passengers and 1 transit and the crewmembers of 7. member of staff, a ground engineer, who was on an assignment to Lagos, boarded the aircraft, giving a total of 77 souls on board the aircraft for the last but eventful flight. The last person to board was the ground staff engineer, whose name was not initially on the manifest, because no ticket or any other document was properly registered against his name. The cabin crew's head count would have appropriately accounted for him.

On ground in Kano, startup clearance was given to the pilots at the time 1219 hours and chock off at 1222 hours for the aircraft to commence its taxing from ramp towards runway 05/23, which was in use, albeit temporarily, to assuage the normal runway 06/24, which was under surface restoration. The aircraft's endurance was 2hours and 40minutes. 5N-ESF was lined up at the threshold for takeoff clearance, which was given by the ATC at 1227 hours. The temperature passed on to the pilots was 36° Celsius and wind was from 170° direction at 7 knots. Then the aircraft commenced its takeoff roll after the weather briefing. The eventful airborne was recorded at 1229 hours with 69 passengers and 8 members of staff on Board. The aircraft was operating out of Kano as flight EXW 4226 to Lagos.

"On the takeoff roll", the Air Traffic Controller gave evidence that the run was sluggish and that there was a sudden burst of dust at the end of the runway and he knew immediately that the aircraft had overrun the runway end. However, the aircraft finally got lifted off, after over-running the end of the runway, continued on the 60 metres (197ft) blast pad and continued onto the adjacent 180metres (591ft) grass terrain, which raised a huge burst of dust knocking off two

approach lamps. Some observers from staff quarters off the sides of the runway were wondering why "this aircraft was exceptionally too low". A couple of motorcyclists on the road at the end of the airport perimeter fence (Please see appendix 5.12) saw the turbine flames from the exhaust pipes and thought that the aircraft was on fire.

Apparently, to the observation of everybody around on the streets near the airport, the aircraft could not climb and eventually crashed into private buildings 1 to 2 minutes after take off from runway 23 and started to rain burning aviation fuel and its disintegrated parts onto the streets of Gwammaja Quarters; a thickly populated residential suburban community located at about 4 km from the The extraordinarily airport, in Kano (Please see Appendix 5.12). uncontrollable mammoth crowd, the enormously seething crowd of the Kano metropolis greatly hampered immediate rescue operations and this disturbed normal aircraft accident investigation procedure, as the crowd surged for many days and weeks thereafter. AIPB was greatly at a disadvantage in the preliminary investigation. The accident occurred at Mallam Aminu Kano International Airport (MAKIA) 12°02'57" North, 008°31'30"East at 1:30PM local time during the day light.

1.2 Injuries to Persons

Injuries	Crew	Passengers	TOTAL	Others
Fatal	7	66	73	30+
Serious	1	2	3	24
Minor/none	0/0	1/0	1	23/NA

1.3 Damage to Aircraft

The aircraft totally disintegrated and completely burnt by the fire that ensued.

1.4 Other Damages

Many private homes and buildings were either damaged or destroyed. Houses and properties on the streets were burnt. Thirty people on ground suffered fatalities, while 24 suffered serious injuries.

1.5 Personnel Information

The ICAO Expert on operations, in conjunction with AIPB officials, conducted the personnel information data in this accident.

1.5.1 The Commander was a 49 years old professional male pilot who held a Nigerian license No. ATPL #2089. He had his medical examinations passed on the 15th January 2002. His License was valid up to 16th July 2002, this means he was qualified for the flight. He started flying as a First Officer in November 1977, obtained an endorsement on the BAC-1-11 in June 10th 1988, flew for sometime and then got type rated on Boeing-727 aircraft in August 1994, which he flew till March 1996 when he took a leave of absence from active flying. He resumed flying again in July 1999 and started flying the BAC-1-11 aircraft with the EAS. He had been flying the type since then till the time of this accident.

Before joining EAS Airlines in the year 2000, he had served with four different airline companies. His aircraft ratings were: Caravelle SE-210, BAC-1-11 and Boeing-727. His total flying experience was 14,219 hours. The commander's hours on type were approximately 7,000 hours. The pilot attended his last simulator training on the 3rd February 2002 and his instrument rating was valid till 12th August 2002. He was remarked to be of "average handling and good judgment" at the end of his last 'check ride'. The Captain was off duty two days prior to the accident, he resumed duty on the morning of the accident, he had, no doubt, rested properly before taking the flight that morning.

1.5.2 The First Officer was a male Nigerian citizen, who was first issued with a commercial Pilot License in December 1981. He was 48 years old and he obtained his Airline Transport Pilot license No. 3209 in January 1992. The pilot's last medical examination occurred on the 4th March 2002, where he still had the license validity restriction of wearing a corrective pair of glasses when flying. His license was still valid till 6th September 2002.

The First Officer had worked with Pan African Airline from 1984 to 1992 flying Cessna 402. He then joined Okada Air to operate BAC-1-11 aircraft from 1992 to 1998 and went back to Pan African Airlines. He

later joined EAS Airline in the year 2000 and remained with the airline up to the time of the unfortunate accident. Before the accident, he had a total flying hour's experience of 8,030 hours and his time on type is 3,350 hours. His aircraft ratings were BAC1-11 and Cessna 402.

It was difficult to determine the exact level of experience of the First Officer, as his personal logbook was not available. experience was determined from his personal file retained by the Nigerian Civil Aviation authority (NCAA) and the file retained by the EAS. The flight time contained in those files was as submitted by the First Officer during his license renewals and simulator checks. From 1981 until 2002, the flying time reported is consistent and realistic.

The flying time reported by the First Officer on the BAC 1-11 for the period of June 1994 until March 2002 is 3,700 hours, for a yearly average of 460 hours. This figure is well within the industry standard of 650 hours per year for a BAC 1-11 pilot in the Federal Republic of Nigeria.

1.6.0 Aircraft Information

There are 244 BAC-I-11 aircraft constructed worldwide by British Aerospace now known as Airbus Industry PLC. The aircraft was designed to operate at the maximum altitude of 37,000 feet and had the passenger seating configuration of 104 persons including the cabin crew. As at May 1st 2002, there were only 50 remaining and out of these 50 not less than 18 were operating within the Nigerian airspace as of the time of the accident.

1.6.1 Airframe 5N-ESF (S/N. 266)

The aircraft, 5N-ESF, was constructed in November 1980 by British Aerospace Corporation and delivered to Tarom of Bucharest, Romania in 1981, who operated the aircraft until it was released in July 2001 to the last operator-EAS. A full "D-Check" was carried out on the aircraft in January 2001 and engine S/N 7900 was installed on the N0.1 Position, while S/No. 7116 engine was installed on the No.2 position. TAROM Engineering and Maintenance Department duly certified these checks and engine changes before it was transferred to EAS Airlines. On the

20th May 2001, however, before the handover at the airframe of 23,807hrs.33mins, engine S/N 7900 was removed from the aircraft

position #1 owing to 'operational reasons' and engine S/N 7901 was installed at the same position on the 26th July 2001. The engine ground run was found to be satisfactory. Also, the Nigerian Civil Aviation Authority (NCAA) personnel went to Tarom for pre-importation airworthiness inspection of the aircraft and the aircraft was duly

registered as 5N-ESF by the NCAA who also issued it with a Ferry Permit dated 30th July 2001 to 6th August 2001 to enable the aircraft to be flown from Bucharest Romania to Lagos, Nigeria. 5N-ESF joined EAS Airlines' fleet in Lagos on 2nd August 2001, was then issued with a full 'Certificate of Airworthiness' valid till 1st August 2002 and started full operation thereafter.

On the 9th March 2002, however, its No.2 engine developed some vibration and loss of power output as a result of which the aircraft was precautionarily grounded for 52 days i.e. from 9th March 2002 to 1st May 2002, awaiting engine replacement.

Another BAC-1-11 aircraft in the EAS Airlines fleet 5N-ESD, developed a ground-cooling problem on the 30th April 2002, which the operator estimated 7 days to be repaired, but owing to aircraft operational demand, the operator then **decided to transfer** engine S/N 7114 from 5N-ESD onto 5N-ESF's No.2 position. On the 1st May 2002, the engine was eventually installed on 5N-ESF, which had been awaiting an engine replacement. Thus, the aircraft resumed flying on 2nd May 2002.

From the time of the installation to the time of the crash, the refitted engine had operated for about 10 hours. On the day of the accident the aircraft's trip would have been Lagos-Jos-Kano-Lagos. It was on the takeoff roll for the last leg of the trip Kano-Lagos that this accident occurred. The aircraft ESF came to the Nigeria's registration at the airframe time of 23,808 hours and crashed at 24,644. It flew for only 836 hours on the 5N registry.

The aircraft's weight at chock off Kano on departure was within the prescribed limit. The actual take-off weight was 39,243kg while the maximum allowable take-off weight obtained from the aircraft certification charts is 47,400kg. The aircraft type uses Jet A-I aviation fuel.

S/N 7114 History 1.6.2 Engine No.1

This engine was constructed in August 1982 and was installed on this aircraft in Romania in 1984. The history of the engine is given here below in tabulated format for ease of reference. Most of the instructions and the actions taken were entered in the Romanian language.

	actions taken	were	entered	in th	e Roma	anian	languag	e			
		I	Engine was	cons	structed:	in Auj Časta	gust 1982. mbor 1981	2:			j
			acked for c	uspat	ON ON	TSI	OFF	Run	Time	Rea	son for Rmval
Installed	Aircraft	Ken	noved	131	VOIN	1 (3)				Sept.	82 – Nov 84 ??
					4.27	7)4:37	(00:00	1	MQD.5298
05 11 84	YR-BRE				04:37 04:37 04:37 04:37			Ent		s in Romanian	
			03 86					344Hn	s / 14ODays Entri		es in Romania
01 09 89	YR-BCJ/2		12 89		04:37 348.32		693hr	rs / 285days Entri		es in Romanian	
01 10 89	YR-BCJ/2	1	09 90		18:32		368:08	227lu	rs / 566days		es in Romanian
11 10 90	YR-BCY/2	1	04 92		41:22	1	375:46		rs / 30days		
01 03 92	YR-BCJ/2	i	03 92		68:28	<u> </u>		•	99 - 282	 	
01 05 92	YR-BCL/l	07	7 02 93	23	75:28)	574;32		•		
	-BVG/1			<u> </u>		 	(20.54 105		6H (223D	Li	
25 02 93	YR-BCJ/I	5	5 10 93		74:32		630:54 307:46	1	7H+163D;		, i.e.
12 10 93	YR-BCL/2	L	4 03 94	i	30:54			1	0H /470D		LP2
14 04 94	YR-BCN/2		8 07 94		07:46 3.707.20			9H / 131D.			
28 07 94	YR-BRC/1	1	6 12 94	5767:26 6576:20			892H / 167D		HP12CD		
04 01 95	YR-BCK/1	1	0 06 95		76:20	3:20 /407.33		1			M LANGUAGE
22 06 95	YR-BCI/2	_ i	0 08 95	1	7:53	03 7,869,32		7H - 75D			
11 09 95	YR-BCK/2	1	5 11 95	7889:35 8296:04					STATOR NR. 2		
28 11 95	YR-BCN/2	0	3 01 96	<u> </u>		1	FITTIS TRICT!	ALLATION, OIL		 	
28 12 95	YR-BCN/2	IN	FRANKFU	RT, E	NGINE K >VUD TU	CUN A DELLE	ELEK MADE SCOOLING	OUIL	El		
	- 3112	<u> </u>	LEAK OBSERVED THRULP COOLING 8296:04 8300:34					REMOVED:		ENGINE SENT TO	
29 12 95 YR-BCN/2		1							RR-CANADA		
03 01 96	ENGINE RMVD FROM BCN/2								HEQIL CONSMPTN		
103 01 90	ZERHAULED AT	ESN 83			Y TARON	4 SA.					
EMOINTERS	TIMITATORES ALTO	-,,,-	• '					rs o/			HPC, HPT.
27 09 96	YR-BC	[/2	17 03:5	7	8300	34	8,850:1	1	549:3	/	LPT,LPC
270970	1				0050	11	9,154:4	7	854:1.	3	BOROSCOPIC
18 03 97	YR-BC	Y/2	2 29 06 9		7 8850		ETT 9,124.4		0.54.		INSP
	YR-BC	K/2 13 11 9		98 9154		147 10,206:3		4	1906.0	00	ENGINE RMVD
02 01 20									& CERTIFIED 24		FOR FOD.
Engine remov	ed and sent to DA	LLA	SAIRMO	ΓΙΥΕ	for repai	rs.	REPAIR	D &	CEKILLIE	. L. 24	1)5, 47071
							VINIOTA I	ı pn	ON SN-E	SD	
1			OUGHT T	O NI	GERIA	ANI	10.526.0	2 <u>060</u>	2,235	<u> 15</u>	OPERATIONAL
17 02 02	5N-E				10,206:34		10,526:22		11H/2D		THE KANO
02 05 02	5N-E	SF	04.05.02		10,520	5:22	10,337	<i>101</i>	1111/	مبو ــ ــــــــــــــــــــــــــــــــــ	CRASH

1.6.3 Engine No. 2 S/N 7901 History.

The SPEY MARK 512-14DW engine, serial numbered 7901 was constructed in May 1977. The tabulated history of the engine runs as below:

Installed	Aircraft	Removed	TSN ON	TSN OFF	Run Time	Rmval Cause
NEW			0010:45			
01.09.78	YR-BCY/2	17 07 79	0010:45	1252:50	1242H rs. / 319Days	Entry Roman Lang.
03 09 80	YR-BCY/I	28 10 81	1252:50	2,835:55	1583H /-420D	
	YR-BCJ/1	17 03 82	2,835:55	3244:20	/408H / 137D	
01 11 81 24 03 82	YR-BCL/1	21 09 83	3,244:20	4,932:00	1688H / 546D	I ST STAGE GV CHG
30 11 84	YR-BCM/2	20 01 85	4,932.00	5,056:25	124H / 51D	
21 02 85	YR-BCK/2	16 04 86	5056:25	6472:45	1416H / 419D	
09 05 86	YR-BCM/2	08 03 87	6472:45	7434:59	962H / 303D	
27 04 87	YR-BCJ/l	22 10 87	7434:59	8051:57	617H / 178D	HIGH VIBRATION
27 03 90	YR-BCN/2	31 05 90	8051:57	8195:09	143H / 65D	HIGH VIBRATION
30 11 90	G-TOMO/2	14 12 90	8195.09	8229:41	35H / T4D	
15 12 90	3 (01/10/2	30 12 90	8229.41	8261:27	-32H / 15D	ON THE A/C MAIN
08.01.91	G-TOMO/2	12 11 91	8261:27	8682:24	421H / 308D	
17 07 92	YR-BCJ/2	07 09 92	8682:24	8905:39	223H/52D	
14 09 92	YR-BCR/2	14 04 93	8905:39	9302.28	397H / 222D	
14 04 93	YR-BRD/2	10 04 94	9302:28	11,009:33	170711/361	
16 06 94	YR-BRB/I	09 10 94	11,009:33	11,488:51	479H - 155D	
21 10 94	YR-BCK/l	02.01.95	11,488:51	11,916:54	428H / 73D	
04 01 95	YR-BCJ/2	30.05 95	11,916:54	12,623.01	1706H/ 146D	
01 06 95	YR-BRC/2	30 09 95	12,623:01	13,313:51	691H / 121D	<u> </u>
03 11 95	YR-BCI/2	20 02 96	13,313:51	13,894:56	581H 109D	
22.02.96					Engine Removed	RMVD DUE FOD
17 07 98	YR-BCL/I	18 02 99	13,894;56	14,304;42	410H 216D	
22 02 99	YR-BCJ	04 10 99	14,304:42	15,037:21	733H / 226D	
15 10 99	YR-BCK/I	31 12 99	15,037:21	15,143:41	10611777	
31 01 00		Engine removed, exercise was four				
02 02 00	5N-ESE/I	22 12 00	15,151:17	16,175:5		Engine removed due FOD
		CONTROL SO MARIA				
26 07 01	5N-ESF/1	04 05 02	16,175:55	16,992:0	0 816H/282D	CRASH @ MAKIA

1.6.4 Aircraft Traffic Load

Before departure from ramp, ESF had 77 souls on board and also uplifted 6,750 litres of JetA-1 fuel and had a total fuel weight of 7,800 Kg. on board. The total allowable traffic load was 9,227Kg but the total

traffic load for that trip was 5.650Kg. The total take-off weight at ramp departure was 39,423Kg with taxi fuel., whereas the aircraft was certificated for the maximum takeoff weight of 47,400Kg. The load-sheet showed that the aircraft was properly laden and the Centre of Gravity was within the prescribed limits during the phase of operation relating to this accident.

1.6.5 Type of Fuel Used

The aircraft, on landing at Kano International Airport on the day of the accident was refueled and serviced with 6,750 litres of Jet-Al type Fuel from the Mobil Oil Nigeria Company. The fueling of the aircraft was done in preparation for the last segment of the flight, Kano-Lagos. But the aircraft crashed shortly after take-off from Kano airport runway 23.

The Accident Investigation and Prevention Bureau (AIPB) officials on arrival in Kano same day of the accident immediately visited the Mobil Aviation Fuel Company, the last refueler of the aircraft, to ensure that no further supply to any other aircraft was made by the oil marketer. The Mobil oil official on duty quickly admitted that fuel sampling had been done in accordance with the company procedure and routine after an aircraft accident occurrence. The AIPB officials in the presence of the Federal Airports Authority (FAAN) and Nigerian Airspace Management Agency (NAMA) officials observed the sample in a jar. Instruction was then given that the fuel sample be forwarded for analysis in a laboratory in Lagos.

Mobil Aviation Fuel Marketer.

Although, the required steps had been taken by the Mobil Oil Marketer employees by taking the fuel sample for analysis, the company personnel was uncooperative and unnecessarily difficult. There should be a better way of doing things in an emergency situation as was on hand on that day of the accident.

1.7 Meteorological Information

Weather was not a factor in this accident. The weather was good and clear as Visual Meteorological Conditions (VMC) were present. There were scattered clouds at 600m and broken clouds at 3300m and the visibility was 20km. The surface winds were from the south at 1700 magnetic at 7 knots. The temperature was 360 Celsius and the dew point was 180° C. The barometric pressure (QNH) was 1003 HPA or 29.94 inches of mercury.

1.8 Aids to Navigation

Though aids to navigation were not a factor in this accident, all the navigational aids at the Kano airport were serviceable.

1.9 Communication

There was good communication between the aircraft and Kano control Tower on the day of the accident. The last communication was when the controller gave the aircraft a take-off clearance. The aircraft never reported any problem before the crash.

1.10.0 Aerodrome Information.

The Kano airport is situated on latitude 008°31'30"E and 12°02'57"North. The airport elevation is 1565 feet above sea level (asl). The airport has two runways designated 06/24(Elev.1562) and 05/23 (Elev. 1502). Runway 06/24 was NOTAMed closed for repairs while runway 05/23 was being used for all take-offs and landings.

1.10.1 The two runways

Two runways serve Mallam Aminu Kano International Airport: runway 06/24 and runway 05/23 (Please see appendix 5.12). The former runway is 3,300m long by 60m wide, constructed of asphalt and concrete. This runway is longer than the latter one, but because a part of the longer runway was being resurfaced for smoother aircraft run, it dictated that the alternate shorter runway 05/23 be used by the Otherwise, military aircraft normally use the appropriate aircraft. runway. There was a NOTAM number 64/2002 raised in that respect by the Nigerian Airspace Management Agency that "KANO:RWY 06/24 closed to flight operations" and the effective date was 1st April 2002 commencing from 0001 hours UTC. During this renovation period, all civil aircraft limited to the Boeing-767 type and of the allup-weight of 156.49 tons were NOTAMed to use runway 05/23 for landing and taking off. The runway is 2,600 metres long by 45 metres wide and its gradient is 1.2 %. Irrespective of the length, all aircraft engaged in local and international flights in the specified category landed and took-off on the runway without any incident since the renovation began. The EAS' BAC-1-11 aircraft with the call-sign EXW-4226 also had to use runway 23 for its take-off on the day of the accident. The threshold elevation of the airfield is 1,502 ft. above sea level (asl).

1.10.2 Airport Emergency Services

The Kano airport had operational services available 24 hours/day. The Emergency Response Services (ERS) were of category 9. The ERS responded immediately to the accident with five (5) vehicles while one (1) MAC-06 12 ERS vehicle remained at the airport for operational purposes. The ERS personnel had difficulty reaching the accident site due to the bad roads and the large crowd of sympathizers. The Airport Emergency Fire Service was, however, supplemented by the municipal Emergency Services. Military Emergency Services from the Nigerian Air Force and the Nigerian Army also committed their resources to the airport situation for the duration of the rescue effort. Despite all the difficulties, fire fighting and rescue exercise were carried out effectively with the support of the Kano Fire Brigade.

1.11.0 Flight Recorders

According to the aircraft documentation, this aircraft was equipped with a Flight Data Recorder (FDR) and a Cockpit Voice Recorder (CVR).

1.11.1 Digital Flight Data Recorder (DFDR)

According to the aircraft documentation as recorded by the NCAA and the operator itself, this aircraft was equipped with a Fairchild FDR Model FD00, Part Number (P/N.) S703-1000-00/YP 154A. However, the DFDR recovered from the accident site was a Plessey Model PV-1584A, Part No. 650/12/14040/04. S/N.2027. The DFDR was taken to the facilities of the Air Accident Investigation Branch (AAIB) at Farnborough, United Kingdom for read-out. decoded from the recorder indicated that the recorder was just a "placebo" or just a lure. All the data encrypted on the tape medium do not correlate with any runway orientation in the country. All the traced trip curves, when the raw data were printed out, were showing perfect curves of takeoffs and landings for the flight duration of 2 These curves showed that there were no problems with the aircraft operations. Whereas, comparatively, most flights within the Nigerian airspace are less than 2-hours' flight duration; mostly just 1 hour or 1.20minutes duration.

1.11.2 Cockpit Voice Recorder (CVR)

According to the aircraft documentation, this aircraft was equipped with a Collins CVR Model 642C-1, Part No.522-4057-002. The CVR could not be found at the accident site and the search for the recorder

continued for a long time. The exercise had to be suspended after the wreckage spread had been well combed for possible location of the CVR. The search for the CVR was broadcast through the local radio station and a specimen was displayed on the local television sets, with the Ministry of Aviation promising a handsome reward for any individual who could assist to find the orange looking box. The CVR had not yet been recovered as at the time of compiling this report and might, as well, be written off as lost or missing.

1.12.0 Wreckage and Impact Information

The aircraft crashed into residential houses in the Gwammaja Quarters of Kano. Gwammaja Residential Quarters is located at about 3 km from the end of runway 23 and directly under the flight path. On the consequential impacts with buildings, the aircraft disintegrated into fragments and many parts were scattered all over the streets, leaving many houses damaged or destroyed or burnt. The wreckage trail covered a large area and many segments of the aircraft caught fire on impact. The wreckage distribution consisted mainly of the two engines, tail components, portions of the wings, the landing gear, a portion of the fuselage and parts of the cockpit area, specifically the center portion of the instrument panel and the pedestal (Please see appendix 5.1). The wreckage exhibited signs of repeated impact forces and a post impact fire.

1.12.1 The Auxiliary Power Unit (APU)

The following evidence was observed:

- The external surface had multiple impact damage;
- There was no sign of external or internal fire; and
- There was no evidence of soot deposit in the inlet, outflow or exhaust ducts.

1.12.2 Instrument Panel and Pedestal

The retrieved instrument panel and the center pedestal were critically inspected and the following observations recorded:

- The take-off trim indicator was set at the first nose-up setting, which was the required setting for this particular takeoff.
- The Vertical Speed Indicator (VSI) showed a rate of descent of 200 feet per minute due to reduced thrust.
- The flap setting indicator was showing 20°;
- Both engine Thrust Setting Indicators (TSI) were set at 77 & 76, which were normal settings for take-offs;
- The No.1 engine overheats light exhibited a cold filament, thus indicating that the light was OFF at impact.
- The No.2 engine overheat light was not retrieved; and
- Both engines 'thrust-reverser' lights showed a cold filament, thus indicating that the lights were OFF at impact.

All the controls on the pedestal were sheared, except for both engine throttles. The No.2 engine throttle was almost at the maximum power, while the No.1 engine throttle was back approximately one inch behind the No. 2 engine throttle setting. The retrieved engines were shipped to Rolls Royce Facilities, East Kilbride for detailed investigations.

1.12.3 The No.1 Engine - (Left)

The following evidence was observed on the left engine:

- The fan blades were generally intact with marks of impact damage;
- The forward stator blades were generally intact with marks of impact damage and, the joining strips between the blades were cracked;
- There was ingestion of debris inside the compressor casing.
- The compressor casing was crimped and the skin was cracked;
- There was no evidence of internal or external fire damage;

- The compressor discharge pressure outlet duct had no deposit of soot; and
- The general condition of this engine indicated little or no rotation at impact.

1.12.4 The No.2 Engine - (Right)

The following evidence was observed: The inlet guide vanes (IGV) were damaged and 2 IGV were ruptured at the base;

- All fan blades were missing and were ruptured at the base;
- Half of the second stage of IGV was missing and the IGV were ruptured at the base;
- The blades of the second stage were bent and seven blades were sheared at the base;
- The third stage of IGV had impact marks;
- There was ingestion of debris inside the compressor casing;
- There was no evidence of internal or external fire damage;
- The compressor discharge pressure outlet duct had no deposit of soot; and
- The general condition of this engine indicated high rotation at impact.

1.13.0 Medical and Pathological Information

No autopsy of the flight crewmembers was conducted as the dead bodies were burnt beyond recognition by post impact fire. As such, it was not possible to determine if incapacitation or physiological factors affected the flight crewmembers performance. The morgues of the Armed Forces Medical Centre near the airport received 22 bodies and the city hospital, Murtala Mohammed General Hospital received more than 61 counted bodies, which were all badly burnt. Some 23 other bodies were distributed over private hospitals in the Kano Municipality.

1.14.0 Fire

There was no evidence of an in-flight fire. But there was a postimpact fire as a consequence of the aircraft breaking up during the impact with the buildings and the ground. Aviation fuel was ignited and fire spread covering a large part of the thickly populated

Many people on ground 20 the airport. near area residential were injured or killed by fire.

Five (5) Emergency and Rescue Services vehicles made their way to the accident site within ten (10) minutes of the alert given by the Air Traffic Controller on duty. The five vehicles included one (1) MAC-06, one (1) Rapid Intervention Vehicle, two (2) Patrol Vehicles (model 397 and 398) and an ambulance. Those vehicles contained a total of 27,100 litres of water and 3,135 litres of foam.

The Emergency Response Services (ERS) personnel had difficulty reaching the accident site due to the bad roads and the large crowd.

Also, the spread of burning wreckage situated in a wide residential area coupled with a hostile crowd made their work more difficult. The ERS vehicles ran out of water and foam very rapidly. Since there was no water source in the area of the accident, the ERS vehicles had to return to the airport to replenish and this did not augur well with the local citizenry. Despite all the difficulties, fire fighting and rescue operations were carried out effectively with the support of Kano Fire Brigade.

1.15 Survival Aspect

The accident was not a survivable type considering the degree of impact with buildings and ground and the attendant fire outbreak. However, there were initially five (5) survivors among the passengers: three (3) persons with serious injuries, one (1) person with minor injuries and one (1) with no injury at all. One person among those that sustained serious injuries died later in the hospital.

Information gathered indicates that the four survivors were sitting in the aft section or near the aft section of the aircraft. All the other occupants sustained fatal injuries as a consequence of the impact and the ensuing fire.

1.16.0

The two engines were retrieved from the wreckage and shipped to the Rolls Royce Engines Facility at East Kilbride, Glasgow-Scotland for detailed stripping and investigations.

1.17.0 Organizational and Management Information

1.17.1 ICAO's Operation Assignment Experts.

Pursuant to the concern to unravel the cause of this unfortunate mishap, the Federal Ministry of Aviation made a request to the International Civil Aviation Organization for assistance in the investigation of the accident. In response, ICAO offered to provide the services on an Operation Assignment (OPAS), basis of which two Accident Inspectors, one in the operations field and the other in the airworthiness field. The experts were, therefore, sent to Nigeria under the OPAS scheme to assist the Accident Investigation and Prevention Bureau in an individual consultant's capacity as part of the Ministry's investigation team. Mr. Serge Lemire came as the Operations Expert and Mr. Syyed Ahmed as the Airworthiness Expert. Also, through the contributive assistance of the British High Commission in Nigeria, another Airworthiness Consultant from the UK was invited to carryout a technical evaluation of the operator's facility and the NCAA. The following, therefore, are the combined findings of the interviews, consultations, auditing and inspections of the NCAA Organizational Setup and that of the Nigerian Airline Operator:

1.17.2 NCAA Airworthiness Department had a total of 26 field inspectors divided amongst five (5) offices. The five offices were located in Lagos, Abuja, Kano, Port Harcourt and Kaduna. Of the 26 field inspectors, ten (10) inspectors had no aviation background. The NCAA Airworthiness Department has a ramp inspection plan, but it does not have a detailed surveillance inspection plan that would cover all airworthiness activities.

The Federal Republic of Nigeria contains about 35 Aircraft Operators and more than 160 registered aircraft of different types. The diversity in the large number of operators having some peculiar organizational safety culture and, a great diversity in the types of aircraft registered combined to the meagre qualitative and quantitative resources of airworthiness inspectors undermines the safety at large.

1.17.3 Executive Airline Services Ltd. (EAS)

EAS was incorporated in Nigeria on the 23rd December 1983. Three years later, the company started to operate cargo flight services between Nigeria and Europe with Boeing –707 Freighters and a DC-8 aircraft for about six years. In 1993, the company diversified into the executive jet aircraft charter business operating such aircraft as

Hawker Siddeley-125, Beechcraft King Air and went on wet lease of a Boeing-727-200. The operator, later on in October 1998 acquired its own two BAC1-11-500 series, which were used as spring board into domestic scheduled airline passenger service operating between Abuja-Jos-Enugu and Port Harcourt. In the year 2000, two additional

BAC1-11-500 aircraft were added to the fleet. 5N-ESF was the latest one and was acquired in July 2001.

The result of an audit inspection carried out on EAS Maintenance Facilities by the ICAO appointed Airworthiness Experts are as follow:

- The Maintenance Procedure Manual, the Exposition Manual and the Quality Audit Manual did not have a Certificate of Approval from the designated NCAA.
- EAS does not have a Maintenance Training Manual.
- No Quality Audit Check records were held, as required at page 7 of section 2 of the Exposition Manual of EAS.
- The organization chart or the duties of various elements were not displayed in the designated work areas.
- The manuals in the technical library were not updated and periodic checks of the manuals were not carried out.
- Contrary to normal practices, the POL storage area was not segregated and was located inside a room where other parts were also stored.
- Toolboxes did not contain a list of tools and, there was no periodic check of the tools to validate the content of the boxes.
- Date of calibration for special tools, tyre pressure and high pressure gauges were not displayed to validate their serviceability.
- Daily aircraft pre-flight inspection records were not held.

- The Aircraft Technical Log book was not signed by the Avionics Engineer to validate the serviceability of the CVR
- There were no inspection records for the serviceability of fire extinguishers.

1.17.4 Air Accident Investigation Branch, Farnborough-UK.

The British Air Accident Investigation Branch has always, for many years, been assisting the AIPB with accident flight recorders, which are installed on the European manufactured aircraft. AAIB assists us both with material and human resources. The doors of their CVR and FDR laboratories are thrown open at our disposals. This accident is not different from any others, the AAIB did commit Mr. Dick Vance in the FDR laboratory and Mr. Chris Pollard to the Roll Royce Facility for the engine stripping.

1.17.5 National Transportation Safety Board. (NTSB) - USA.

In response to the Ministry's clarion call for assistance in the investigation of the probable cause of such a catastrophic mishap to the Nigerian registered BAC1-11 aircraft, The Embassy of the United States of America in Nigeria arranged with the NTSB, Washington D.C. and the Regional Operations Chief, Mr. Dennis Jones arrived in Abuja on the 17th May 2002 to render a great assistance by visiting the site of the accident in Kano and also did some documentary investigations in Abuja before returning to the United States. Most of the senior officers at AIPB have, one time or the other, passed through the kind assistance of the NTSB in Washington for on the job training and also for the readout of flight recorders from the American manufactured aircraft.

1.17.6 Rolls Royce Engine Facility - East Kilbride, Scotland-UK.

The Rolls Royce Company manufactured the powerplant of the BAC1-11-500 series. Hence the engines were shipped to the manufacturer. The E. Kilbride factory built the Spey 512-14DW engines before they were discontinued. Manufacturing of other more advanced, more powerful and more modern engines are still in process at this factory. Mr. Rob Norbury was the lead investigator of the Engine Failure Investigation Unit at Rolls Royce Headquarters at Bristol, England. He was assisted by Mr. Ian J. S. Davidge, a Senior

Engineer from Bristol Hqtrs. Engine overhaulers at E. Kilbride: Donald Currie, Alistair Skea, Thomas Hastie and Bob Fernie were all restricted to the investigation for the whole period that AIPB was at the facility.

1.18.0 Additional Information

1,18.1 The Acetylene Torched Engine

The unorthodox Special Investigating Techniques just have to be mentioned in here and it is of no consequential effect on the conduct of the investigative method employed. Two ICAO nominated experts joined the AIPB on Wednesday 29th May 2002 to assist in the field investigation of the crash and the crash site. Mr. Serge Lemire and Mr. Syyed Ahmed came from Canada and Mr. David Gee was representing the interest of BAE/Airbus Industries. The Chief Investigator-In-Charge of the accident, Mr. R. Faminu was also in this team.

The team had agreed on the previous day on site at Kano, that both engines would not require further inspections in Kano and they would be sent to the Rolls Royce Facilities in East Kilbride, Scotland for a complete inspection in a controlled environment.

On the following day, Mr. Syyed woke earlier than the rest of the team and headed for the engines without discussing his intentions with other members and directed that the engine No.1's compressor casing be cut open with an acetylene torch. The Airport Manager felt that the procedure was wrong and he quickly dispatched a patrol vehicle to intimate the rest of the team members. When the action was queried, Mr. S. Ahmed explained that he was looking for soot deposits on the compressor blades and had, therefore, decided that this was the best procedure to obtain the information. The procedure was stopped but the damage to the compressor casing had been done. A one-foot by one-foot permanent acetylene cut hole had been established on the engine compressor casing. A report was launched with the ICAO Field Operation Officer, Montreal, Canada. The Honourable Minister of Aviation also informed the ICAO Headquarters. Mr. Ahmed did make an official explanatory response to the Honourable Minister of Aviation that "the motive behind the acetylene cut was to see inside condition of the engine to validate the evidence of hot compressor stall, a focal point in the investigation". This explanation is not acceptable to the Accident Investigation and Prevention Bureau nor was it acceptable to the Rolls Royce Engine Manufacturer.

Fortunately, this procedure did not annihilate any investigative process at the Rolls Royce Facility. The procedure was only described as inappropriate.

1.18.2 A Surviving Passenger's Evidence.

Many months after the accident, AIPB was able to track down one of the four lucky survivors of the accident. Although, on the day of the accident a brief interview was conducted with the only surviving Cabin Crew – Ms. Naomi Ukpong on her sick bed. She said she saw nothing, because she was sitting at the rear of the cabin. Mr. B. A. Adeshina was eventually interviewed on the 25th November 2002 at his Ikotun Road, Isheri Roundabout residence.

Lucky Mr. Adeshina was kind enough to give evidence that he was a conversant air traveler since 1998 and started to be a frequent flyer on the EAS in 2001. He said he was sitting at the centre of the cabin close to the window, where the emergency door was located. Sitting next to him was Mr. Najeeb Ibrahim a Lebanese national. Mr. Adeshina did not fasten his seat-belt for the takeoff, but he admitted that the act was unusual of him.

He observed that the take-off roll in Kano was normal to him until the aircraft crossed the white markings on the threshold of the other end of the runway. At this point he became uncomfortable thinking the aircraft should have taken off before this point. At a point, he noticed the aircraft had taken off while the rear tires of the aircraft hit the approach lights and serious dusts were raised and the aircraft was distressed and shaken to its foundation. He noticed some fluorescent covers in the cabin fell off.

When the aircraft hit those structures, he noticed some drop in the speed and stability of the aircraft, though still gaining altitude. At a stage, he peeped out of the window and discovered the aircraft was not gaining altitude but relatively stabilized. He was worried but kept it to himself and he observed the houses were just few metres below the aircraft. Then the impact occurred, which was followed by darkness, that enveloped the cabin and the aircraft was on fire. There was pandemonium inside the cabin but he chose to remain on his seat and started to pray, "God, I shall not die inside this aeroplane in Jesus' name" and he closed his eyes

Mr. Adeshina continued the narration of his experience saying that the next thing he could recollect was that he found himself under a shed of a building and the environment was calm and he, therefore, opened his eyes only to find Mr. Najeeb Ibrahim beside him and he, Najeeb, greeted him. Miraculously, Mr. Ibrahim was completely unscratched by the accident and they both saw a staircase of the building through which they went up. It was there they saw two Hausa boys beckoning to them to jump down from the building and they jumped onto the roof of a boys-quarters building attached to a house from where they jumped down to the ground. These boys took them to the Murtala Mohammed Hospital, which was not too far from the crash site.

As at the time of this interview, Mr. Adeshina was still making arrangement to travel abroad for skin graft surgery, because of the severity of the burns over this body.

1.19.0 Useful or Effective Investigative Techniques

The two engines were taken to the manufacturer's facility in East Kilbride, Scotland for detailed inspection to ascertain their power output performance and also, if there had been any malfunction with any or both of them. Engine No.2 was first disassembled, because it looked good with no tell tales of the expected damage typical of such an accident. The contention was that the engine might not be operating when the impact occurred.

1.19.1 Engine No.2's disassembly

On disassembling, the engine was found to be delivering maximum thrust as at the time of the first impact with the buildings at Gwammaja Quarters. An indication of this was that the thrust bearing on the engine was greatly heat soaked, giving a black coloration around the bearing, because of the sudden stoppage of the turbine power. The sudden stoppage had cut off lubricating oil supply to cool the bearing through the normal process. So the generated heat would give the darkened coloration around the bearing.

Another observation on the engine was that the mating spaces between the high pressure compression area was, unusually, filled with well compacted dust particles, which no one could give immediate reason to its presence around the area. Samples of the dust particles were extracted and forwarded to Rolls Royce, Germany for

laboratory test and analysis. This did show that the dust ingested after the grassy runway end had been well compressed by the high-pressure compressor blades. The engine was performing well and at high power setting at the point in time.

1.19.2 Engine No. 1

Engine No.1 was disassembled second and the type of compressor damage to the low-pressure compressor blades are very similar and consistent with the type of impact. There was no mechanical failure found that could be attributed to the pre-accident impact failure. There was also some discoloration found around the main bearing, but to a lesser degree when compared with engine No.2. This simple evidence showed that the engine might not be running at a high power setting as in the engine No.2. To determine the percentage of the power output during the impact, BFU in Germany would be contacted for the analysis.

2.0 ANALYSIS

2.1.1 The Flight Crew

The Pilot-In-Command was found to be a professional pilot of many flying hours experience, about 15,000 hours, which were accumulated within 11 years period of real flying. His total type experience were about 7,000 hours on the BAC1-11 aircraft pro-rated from available documents, because his "Personal Flying Logbook" was not obtainable for investigations after his demise. The pilot became an Airline Transport Pilot License holder on the 28th February 1986 when he was on the Caravelle SE-210. In the interim, he had flown Boeing-727 and the BAC1-11 for Kabo Air Ltd. On the 22nd March 1993, the Commander swore an affidavit in the High Court of Lagos State that his license and other documents were misplaced in his flight bag. The pilot's license then was renewed up till 1st October 1996 and then the pilot went under without any explanation only to reapply for renewal of the license on 26th July 1999 and that was when he resumed flying with EAS on the BAC1-11 aircraft fleet.

The Commander's medical examination was performed on the 2nd March 2002 and therefore was valid till 14th July 2002. His last simulator was done on the 3nd February and became valid till 2nd August 2002. His Instrument Rating was valid until 12th August 2002. He was claimed to have attended the British Airways Cranebank Facility, UK on the 28th January 2001 for the BAC1-11 simulator recurrent training. The Pilot had his 3-day rest period: 1st May to 3rd May 2002 and then resumed duty on the 4th, the day of the accident. The commander, therefore, was well rested before duty and was very competent to command the flight of the BAC1-11 on that day.

2.1.2 The First Officer

The First Officer was 47 years old and held a Nigerian issued Airline Transport Pilot License number 3209, which was valid till 6th September 2002. He had a total flying experience of 8,030 hours and about 3,350 hours on the type. He had had experience on Cessna Conquest 441 amounting to 3,471 hours. On the 20th February 1991, the Pilot swore to an affidavit that his Commercial Pilot License got lost and another was re-issued in duplicate to him. On the 22nd January 1992, he applied for and got his CPL document converted to Airline Transport Pilot Licence. He was qualified because he secured the USA-FAA ATPL certificate. He, briefly, had a flying stunt with

Okada Air on the BAC1-11 fleet. It was inferred from his records that, between 7th March 1995 to 10th June 1997, the pilot did not show any positive means of employment with any airline, though he was renewing his flying document as of when due. In June 1999, the First Officer applied for the renewal of the document when he gave his address as Pan African Airlines. At Pan African he was back to flying the Cessna series of aircraft, which are smaller than the jetliners he was flying before. The pilot remained with Pan African until May 2000 when he resumed flying for EAS from 8th August 2000 till the time of this accident. The First Officer was off duty on Tuesday; flew on Wednesday and Thursday; rested on Friday the 3rd and resumed flying on Saturday the 4th May 2002. He was, equally, qualified to take the flight.

AIPB's Observation of Airline Personnel

From AIPB's experience, it seems that a pilot's flying documents must get lost at one time or the other in the course of his flying career. There must be an inherent reason for most of the pilots, who are engaged in the practice of doing this. This Bureau would like to recommend that the Personnel Licensing Department of the NCAA should look into this habit and investigate properly the occurrence of lost flying documents of some certain pilots in the course of their career. Is it to manipulate their cumulative flight hour experience, or to covertly misrepresent information to the Authority?

2.2. The Aircraft

The aircraft was properly certificated by the Nigerian Civil Aviation Authority and had been maintained in accordance with the approved airworthiness requirements of the Aviation Authority of the land. There was no history of related failure or event that could be associated with this accident.

Although the aircraft was manufactured in the year 1980, nothing could be inferred to associate this accident with its age, because all the mandatory modifications and inspections were accomplished as of when due. Right from Bucharest, when the aircraft was in the service of Tarom, the maintenance of the aircraft was very superb. The total airframe then was 23,807 hours and 12,891 landing cycles. A complete "D-check" was performed on the aircraft on or before 30th April 2001.

The weight and centre of gravity schedule was performed every five years according to the manufacturer's specification. The last of such schedule was performed on the aircraft in Bucharest on the 18th December 1997 and the centre of gravity was calculated to be within the safe range. The Romanian Civil Aviation Authority requires that the Pilot-In-Command verify this himself before taking off that the load is of such a weight and is so distributed and properly secured, that it may safely be carried on the intended flight. AIPB is not sure whether the NCAA has this piece of advice or requirement for the Nigerian Pilots, if not, it will be very essential for them to do so. Incidentally, the Pilot-In-Command of ESF signed the load sheet, but it is doubtful if he did the loading and the distribution verification before signing and proceeding with the flight.

2.2.2 Mandatory Aircraft Modifications and Inspection Programs.

As an aircraft is ageing, the manufacturer issues out series of inspections and mandatory modifications of some critical structures of an aircraft, which are dictated by field experience. These modifications and inspections give assurances that the structural members of the aircraft will not fail. These maintenance instructions are issued as Service Bulletins, Advisory Letters and Airworthiness Directives, which are all mandatory whenever applicable to any particular type of airplane, which must be complied with by all operators.

AIPB found out that all these airworthiness directives had been embodied into 5N-ESF before the ownership transfer to the EAS was effected in July 2001.

2.2.3 Ageing Airplane Corrosion Prevention and Control Program. (CPCP) When an airplane approaches its design age, either in flight time measurement or in calendar time, corrosion becomes more widespread and is more likely to occur concurrently with other forms of damage such as stress corrosion cracking and fatigue cracking. Corrosion degrades structural integrity and if uncontrolled, will reduce the inherent ability of the metal to sustain fail-safe loads in the presence of other forms of damage. Therefore, the overall metallurgical and structural reliability of the metals become more critical than when the Structures were new; particularly when they have gone through the test of time under continuous exposure to adverse operating weather conditions.

There are areas in the aircraft that are periodically washed with water and solvents e.g. toilets and galleys, which are prone to pitting and crevice corrosion attacks. These are local corrosion damages characterized by surface cavities usually accompanied by the powdery residue of corrosion products. To prevent this insidious metal deterioration, manufacturers and metallurgists believe that geriatric (ageing) airplanes require repair, or partial or complete replacement of principal structural members as defined in the manufacturer's structural repair manual. The best way to achieve this is to call for inspections, wherein all systems, equipment, interior furnishings etc that may prevent adequate inspections are removed and then apply appropriate treatments to any deteriorated structural members in the airframe before any failure occurs.

This procedure is called 'Corrosion Prevention and Control Program' which evolves the minimum requirements for preventing controlling corrosion problems that may jeopardize continuing airworthiness of an aircraft. The program is primarily aimed at protecting the ageing airplanes and its early implementation is required to ensure timely prevention of unacceptable combinations of corrosion and other forms of damage in ageing aircraft. The CPCP is usually accomplished during a heavy maintenance such as 'D-Check.' 5N-ESF was subjected to this program and a 'Certificate of Compliance' was issued on the 24th January 2001 before leaving the Romanian registry (please see Appendix 5.16 for the certificate). The aircraft was, therefore, presumed to be structurally sound and airworthy and the fact that there were no indications of airframe break-up during the take-off run attest to the aircraft's structural integrity and maintenance.

AIPB's Findings about the Aircraft's Maintenance Status.

For all purposes, all known mandatory aircraft modifications and inspections were incorporated into this aircraft as of when due. All recommended Service Bulletins, Airworthiness Directives, and accomplished. been had manufacturer's recommended inspections, maintenance necessary for Schedule the continuous airworthiness up-keeping of the aircraft were carried out in accordance with the manufacturer's specifications. AIPB did not find any maintenance error or omission that might have contributed to the cause of this accident as far as the maintainability and the reliability of the aircraft are concerned.

2.2.4 Aircraft Technical Logbooks

Considering the above maintainability and reliability of the EAS aircraft, 5N-ESF's maintenance seems to be in proper perspectives, but where the operator's shortcomings seem to be lingering is comparable with any other Nigerian operator in the aviation industry. For instance, the impropriety of keeping the Nigerian registered Aircraft Technical Logbooks. The Airline Operator does not pay much attention to the proper use of the Aircraft Technical Logbook in accordance with the Nigerian Civil (Air Navigation) Regulation 6 sub-section 5:

"On termination of every flight by an aircraft registered in Nigeria for any of the purposes specified in paragraph (1) of this Regulation the commander of the aircraft shall enter in a technical logbook:

(a) the times at which the flight began and ended; and

(b) particulars of any defect in any part of the aircraft or its equipment which is known to him, being a part to which a maintenance schedule relates, or, if no such defect is known to him, an entry to that effect: and shall sign and date such entries:" etc.

When the ICAO Airworthiness Expert and a UK based Airworthiness Expert from BAINES-SIMMONS, who were invited to conduct airworthiness assessment and to audit the Nigerian registered airplanes and their Operators. The followings are some of the findings observed by the visiting experts:

A review of Technical Logbook pages shows that only 2 certifying engineers have supported the operation of the aircraft since its arrival in Nigeria on 31 July 2001. The majority of certification were made by Mr. A. Ameen, who on one occasion worked for 34 consecutive days with no rest period at all. (Sheet pages 795 – 878, 15th January to 17 February 2002.)

RECOMMENDATION: Whilst there is no evidence of maintenance error found in connection with this accident, the practice of working for extended periods with no break has been shown to have a significant effect on maintenance standards. NCAA should ensure that operators employ sufficient engineers to reduce the likelihood of maintenance error.

EAS Technical Logbook does not have provision to report:

- 1. Serviceability or "trip set" provision for recording each flight CVR and FDR settings on daily basis. That are, no entries validating the daily inspection record for the CVR and the FDR were not provided for in the company's Aircraft Technical Logbooks nor were they made on a separate daily inspection sheets.
- EAS Technical Log does not have crew provision for fuel uplift on its sector trips.
- 3. EAS does not have provision on the pages of its Technical Log sheets amount of engine oil replenishment so that the rate of engine oil consumption by the engines can be monitored.
- 4. The cruise performances Data/Trend Monitoring block in the Technical Logbook were left uncompleted for the majority of the flights.

The above inadequacies in Aircrafts Technical Logbooks do not apply to EAS operations only, but also to most airline operators in the Nigerian aviation industry. NCAA has to impress it on all operators operating in Nigeria to redesign the pages of the Aircraft Technical Logbook to accommodate the above but not limited to the above aircraft operational information.

From the AIPB's observation over the years, Nigerian airline commanders have been flouting this Regulation time after time and again. Pilots can fly for months, exhausting pamphlets of Technical Logbooks after another and there wont be a single component failure or discrepancy entry in the logbook, yet the aircraft maintenance engineers continue to rectify major problems, which the pilots must have detected, in-flight.

Some of the exploitations of the 5N-ESF's technical logbook are illustrated here over leave:

On the EAS' **Tech.** Log page number 0000896, there were five flights of the day 8th March 2002 the flight crew had entered 'NIL' discrepancies for the five flights. But the maintenance entries read - #2 Engine FFR replaced due slow to acceleration. S/N - OFF B1934R S/N - ON B3602R Dated 07 March 2002.

Los of power and vibration.

Engine #2 replaced.

No.2 engine oil Xmitter replaced

S/N - ON = AA16738

S/N - OFF = RP19423

On page # 0000898 dated 2nd May 2002

-Many jobs done with different dates were lumped together. One dated 8 April 2002 and another one dated 1st May 2002.

AIPB observes that this is not the best way to keep a respectable and honest maintenance record. The NCAA needs to audit the airline operators' Technical Logbook from time to time. If the Nigerian airline operators refuse to grow and use the Logbook the right way, the onus is on the NCAA to make them do it the right way.

2.3.0 The Meteorological Condition.

The Visual Meteorological Conditions, which prevailed on that day, and the mild surface wind of 7 knots from the Southeast were not a contributory factor in this accident.

2.4.0 Organizational Information

2.4.1 The Operator

Executive Airline Services Limited is a small airline operator, whose top echelon management staff members are aviation professionals who have achieved much experience from the aviation industry in the country. Its managing Director is a professional pilot, who still holds currency on the BAC1-11 aircraft and still commands the cockpit and not just as an observer in the cockpit. Such an organizational setup should know better the proper use of the Aircraft Technical Logbooks and respect the Civil Aviation Regulations on the proper way to use the on-board document. The way the crewmembers try to prevaricate the aircraft malfunctions discovered in-flight does not augur well for the industry and it is not law abiding.

The same improper way of using the Technical Logbook by the maintenance personnel left more to be desired for honest and confident workmen. Aircraft Engineers should try to respect the Aviation Regulations by keeping honest and proper records of the repairs on the aircraft. The Technical Logbook found on the ESF portrayed lack of knowledge of how to keep proper aircraft record or may connote that they have ulterior motive, which they may wish to cover up if anything happens such we had on ESF. There were lots of incomprehensive entries found by the AIPB and also by the foreign airworthiness experts.

2.4.2 The NCAA - Airworthiness Department

The Nigerian Civil Aviation Authority's Airworthiness Division, surprisingly, seems not to be in total control of both the Nigerian registered aircraft and the Nigerian Operators in general. The aircraft inspections are not receiving proper attention, especially, when Surveyors are about to issue Certificate of Registration (C of R) and the Certificate of Airworthiness (C of A). It is not proper if the operator could present documentation for one Flight Recorder and an entirely different Recorder is actually installed. It is, either the operators are exploiting the ignorance of the Surveyors about airplane components, or some surveyors actually connive to allow the operators to have their ways.

It was also discovered during the Airworthiness Department's audit by the OPAS from the ICAO invited by the Ministry that the NCAA has a total of 26 field inspectors divided amongst five offices. The offices were located in Abuja, Lagos, Kano, Port Harcourt and Kaduna. Of the 26 field inspectors, ten inspectors have no aviation background. The NCAA Airworthiness Department has a ramp inspection plan, but it does not have a detailed surveillance inspection plan that would cover all airworthiness activities.

Another Airworthiness Expert from the United Kingdom who carried out audit of the department tacitly put it this way: "those who are to inspect aircraft for airworthiness purposes and conduct audit of approved organizations, are those who know what an aircraft is and what Aviation Regulations are, 'The best gamekeeper is a converted poacher". What this means is that, for the NCAA to field those who do not have aviation knowledge as airworthiness surveyors is very degrading, the Authority is, therefore, advised to look inward at the

aircraft engineers in the industry, who know the nitty-gritty of aircraft maintenance and hire them as Surveyors.

2.5.0 Aircraft's Flight Recorders.

Before 5N-ESF was de-registered from the Romanian registry, Collins CVR was recorded on the NCAA document that type 642C-1, part number 522-4057-002 was fitted to the aircraft. The serial number was not indicated. It was also documented that the Flight Data Recorder (FDR) was manufactured by Fairchild as type FD000 under part number S703-1000-00/PV1584A. The serial number was not also mentioned on the avionic equipment list submitted to the NCAA official and neither did the officer document the serial number of the equipment.

2.5.1 Cockpit Voice Recorder

All efforts were made to recover this recorder from the aircraft's wreckage immediately after the accident and for several weeks thereafter, but no CVR was discovered. Concerted efforts were made by the AIPB at reaching out to the Kano Metropolitan populace, through the local radio announcement and display of a similar CVR box on television sets. The Federal Ministry of Aviation promised a handsome reward for anybody who could help find or recover 'this orange color looking box'. None of these efforts yielded a positive result to recover the CVR-box. The operator was interrogated on many occasions, if the CVR was ever installed on this aircraft, but the airline remained adamant that a CVR was installed.

2.5.2. Flight Data Recorder.

At the crash site on the day of the accident, a Digital Flight Data Recorder (DFDR) manufactured by The Plessy Company Ltd P/N 650/1/14040/001, model PV 1584A TSO #C51A S/N 2027 was retrieved detached from the usual airframe mooring position. Although in contradiction, the aircraft documentation recorded a

Fairchild FDR part number 2028 to have been installed on the aircraft. On the discovery of this contravening and contrasting records, AIPB then discovered that, somewhere in the Aircraft Airframe Logbook page 08, an aircraft engineer had entered "FDR Unit Replaced. S/N.-2028 - ON; S/N 2027 - OFF, EX ESD"

AIPB found this entry to be fictitious and fraudulent, because there is no possible way a FAIRCHILD manufactured FDR can have a consecutive serial number 2027 with a PLESSY COMPANY manufactured DFDR serial numbered 2028. It is an odd coincidence and one in a million probability that such two equipments manufactured by two entirely different companies, can end up in the same country and with the same operator. AIPB considers this to be a false logbook entry, which is contravening the Nigeria Civil Aviation "A person shall not willfully (Air Navigation) Regulation 55 (2) mutilate, alter or render illegible any log or other record or knowingly make any false entry in or material omission from any such log book number in this record is an offence punishable under the Nigerian Civil Aviation Regulation

However, when the retrieved DFDR was taken to the UK-Air Accident Investigation Branch, Farnborough for the readout, all the recorded data had no relevance to any Nigerian runway orientation. The readout information were displaying the landings on runway 0830 and taking off on 263° orientations, which do not exist geographically or in alignment with any runway orientation in Nigeria. example shows taking off on runway 1820 and landing on 0950 and many of the flights endured for about 2 hours duration, whereas most flights in Nigeria last for only 50 minutes to 80minutes duration. Another flight took off on runway 350 heading and landed on 180 runway heading. These are unfamiliar runway headings in Nigeria.

Close observations show that none of the avionic components had a Analysis of this recorded serial number made by the NCAA. irregularities started from When the NCAA visited Bucharest to perform the pre-importation inspection of the aircraft, the officer indicated on the "NCAA's application for issue of certificate of airworthiness" item 5(h) under "Radio fitted (List of avionics equipment to be attached" and that was what the officer just did. He

attached a list submitted to him by TAROM, the former owner of the aircraft when it was registered as YR-BCN and he merely attached the paper listing 24 other avionic equipment without verifying whether they were actually in place and are corresponding with the listed serial numbers. Without the serial number, nobody can categorically vouch that the displayed equipment have not been switched around after the deal had been sealed.

AIPB believes that this blind acceptance is untidy and too trusting. The normal provision is for the NCAA official to physically sight these avionics equipment and copy the serial numbers from the equipment data plates, which are attached to the front or back of the components. It's an axiom of 'seeing is believing' and nobody will be swindled. The NCAA had designed the right form, but a negligent officer who went for the registration procedure was too assuming.

2.6 Aircraft Performance.

In general, it may be said that the airplane's objective during the take-off run is to obtain sufficient lift to support the weight of the aircraft with the least possible run on the runway. In order to obtain a safe or avoid an unpremeditated air-borne, it is usual to keep the aircraft on the ground by applying some forward pressure on the control column, although this will add, significantly, to the drag force acting on the aircraft initially and will make the aircraft to consume a relative portion of the available length of the runway. This practice is the norm and does not contribute to an accident, provided the pilot reduces his forward pressure as the speed builds-up for the eventual lift-off. In considering an aircraft performance for the take-off phase, the following conditions have to be carefully analyzed:

- (i) Engine Power
- (ii) Airport Elevation
- (iii) The Temperature
- (iv) Runway Gradient
- (v) The Runway Length
- (vi) Aircraft's Weight and
- (vii) The rate of climb

2.6.1 The Engine Power

The two Rolls Royce Spey 512-14DWE engines produced a combined output of 24,000 pounds (12,000Ibs each) of thrust in all regime of the

aircraft's flight. These engines are mounted on the rear tail cone section of the aircraft, in normal cases, out of the fuselage's wake or the normal flow of the undisturbed air.

After the accident, the two engines were transported by air freight to Rolls Royce, East Kilbride Facility for possibility of power failure or any damage before and during the take-off roll at Kano on the day of the accident. Complete stripping of the two engines showed that:

- (i) Neither engine suffered major mechanical failure before the first impact with buildings at the Gwammaja Quarters Residential Area of Kano City.
- (ii) At the stripping, damages observed on the intake
 Low Compressor rotors of the numbers 1 and 2
 engines were very similar and consistent with the
 type of impacts.
- (iii) Type of damage to the No.1 engine's High Pressure Compressor Section was suggesting that the observed impact depression on the external surface of the compressor casing could have affected the compressor blades and stators while the engine was still turning at high RPM.
 - The detailed inspection of the No.1 engine's thrust
 Bearing housing showed comparatively less heat
 soak discoloration than the No.2 engine's,
 indicated that the engine might not be producing at
 high power. Roll Royce, Germany, had indicated
 interest and would like to determine amount of the
 power being generated when the impact occurred.
 - (v) The No.2 engine's Inlet Guide Vane and the Low Pressure Compressor Rotors and Stators showed a great deal of damages and ruptures at the base of the rotors. All the Fan Blades were missing, which was indicative of damage at high engine rotation.
 - (vi) The third stage of the Inlet Guide Vanes had

impact marks and there were damages and debris ingestion inside the compressor casing, but there was no sign or evidence of soot deposit in the compressor discharge pressure out-let. (vii) - All the members of the engine failure investigation

team agreed that there was no pre-impact engine damage and failure, which could have caused seizure of engine rotation at the take-off run.

2.6.2. The Airport Elevation.

Kano Airport Elevation is 1,565 feet above sea level and runway 05/23 elevation is 1,502 feet. The implication of Airport Elevation is that the higher the airport is, the less the atmospheric air density. The performance of a jet engine will be reduced with lower density, whereas the performance will be increased with increase in the atmospheric density, which is naturally maximum at sea level. A pilot should start to get concerned if he is taking off from a high elevation airport, say like in Mexico where the elevation is about 4,500ft above the sea level.

Kano Airport Elevation did not critically affect this airplane when the Airplane's Flight Manual was consulted. It was, therefore, safe to take off on Kano Airfield any time, as far as atmospheric air density is concerned.

2.6.3 The Airport Temperature.

The Department of Meteorological Services (now known as The Nigerian Meteorological Agency – (NIMET) released a trend landing meteorological forecast for Kano Airport for that hour reporting the temperature of 36 degrees Celsius for the time 1200 hours UTC, which is 1 o'clock post meridian local time. The next NIMET report was issued at 1230 hours UTC and said that there was "No significant change" in the temperature.

2.6.4 The Runway Gradient.

Runway 23 at Kano has the gradient of 1.2 %. What this means is that from the threshold of the runway towards the end of the opposite threshold, the height of the runway only rises about 1.2 units of measure vertically for every hundred units of measure horizontally.

The Aircraft Flight Manual's Performance Chart was consulted for the calculation of the chances that the airplane would take off successfully on that day on the runway in use. The Flight Manual guarantees that

the taking-off on the runway with only 1.2% gradient was no problem at all.

2.6.5 The Aircraft's Weight.

From the available load-sheet, the aircraft was properly loaded with the actual takeoff of 39,243kg and the designed maximum all-up-weight of 47,400 kg. At 39,243 kg, the Flight Manual Performance Chart says the aircraft needed only 2,347 metres (7700ft) of the runway length for an uneventful takeoff run.

2.6.6 The Runway Length.

The runway in use had just been NOTAMed and was declared opened to all traffic up to Boeing-767 equivalent for landing and taking-off. The NOTAM came into force in the midnight 1st April 2002 and the accident occurred 34 days after, but 5th May 2002 was the first time in the recent time that the crew flew into Kano and took off on the runway. The crew was psychologically oblivion of the fact that the runway length of 2,600 metres could be a factor in the takeoff roll and so, did not take cognisance of its shortness as compared with other runways.

The length of the runway is 2,600 metres (8,530ft). Checking with the Aircraft Flight Manual for its performance under the loading condition for that particular flight, the amount of runway length required for the take-off was given as only 2,347 metres (7,700ft). The accelerate-stop distance provision under the same aircraft loading condition is 2,530 metres (8,300feet), which means that if the aircraft had been accelerated to the pre-rotation speed, (V₁ = 125 knots) and recognized that it was no longer safe to continue with the takeoff, the aircraft could still be safely stopped within the remaining runway distance. Pilots are trained to be readily prepared to handle this takeoff/abort procedure, but the pilots on this day did not see any reason to abort the takeoff run, because all engine parameters did not call for the action. Then what went wrong with this flight?

In the absence of the cockpit voice recorder (CVR), which could have given investigators an earshot into what went wrong, the CVR in this accident could not be retrieved from the wreckage. The Flight Data Recorder (FDR) on the other hand could have revealed the engines' parameters if anything had gone wrong with the functionality of the engines, but the FDR was not working on the aircraft. Consequently, no investigative assertions could be applied in the investigation of this

accident further than tire marks on the runway and the evidence of the eyewitnesses. The tire marks remained perfectly on the center-line of the runway, indicating that the two engines were delivering power equally and therefore, there was no asymmetric thrust, i.e. no engine failure.

AIPB wants to believe that the crew was too lackadaisical and was not prepared for the sudden runway end, which confronted them as opposed to the lengths it had been psychologically used to for many years of operation on the longer runways. For instance, the crew departed from Lagos Runway 19L of length 2,745 metres (9,000ft) and landed on Jos Runway 23 which is 3,000 metres (9,843ft) long. It took off from Jos Runway length of 3,000 metres and still had some adequate length of the runway left over to play with. Probably, that was the first time the pair had ever landed a BAC1-11 aircraft on the runway 23, which is 2,600 metres. Evidently, the contingencies of operating on the shorter runway were not seriously considered before the commencement of the takeoff roll. This very important aspect could have been totally neglected by the crew, who might have taken the pre-departure briefing for granted. The opportunity of the AIPB's considering this required aspect of the Cockpit Resource Management (CRM) was not available owing to the absence of the CVR.

If there had been failure in the engine parameters or the presence of any other anomaly, the crew could have aborted the takeoff safely before the V₁ and the aircraft would still be safe on the ground. For speed beyond V₁, pilots are trained to continue with the rotation and get the airplane airborne, take control of the situation and then later consider what solution there is to the problem. The pilot would be left with the option whether to come back and land on the same runway of departure or to continue with the flight, if he or she could contend with the problem without any danger to life and property. This takeoff run could have been aborted successfully, if the crew was aware of the problem ahead of them. However, since all other instrument parameters for the takeoff were in agreement with other contingences, the crew did not see the need to abort the take off. To them, everything was all right until the reality of the end of the runway was apparent on them.

Normally at the beginning of the takeoff run, all heads and attention of the crew are more concentrated in the cockpit, monitoring the engine parameters and the airspeed indicators and this might have been a little bit delayed than necessary, not considering that this runway is shorter than others that they have been accustomed to and therefore need more planning before the takeoff. By the time that the attention was shifted outside the cockpit, it was too late for any preventive action to be taken by the crew. The airspeed could have been between V1 and VR and that would have been too late for any evasive or abortive action from the crew. The runway's end-over-run Generally speaking, the decision making of an was inevitable. airplane's pilot is a major component of what is variously regarded as situational awareness, crew airmanship and good flying judgment. The 'situational awareness' of the shorter runway was not there on that Saturday; the keen airmanship that was utterly necessary was, also missing in that there was, obviously, no briefing on the issue of the shorter runway, if at all, the crew was cognisance of the dimensional differences of the two runways at MAKIA. Failure to observe any variety in the runway distance can be categorized as a The CVR could have 'judgment error' on the part of the crew. vindicated the crew, if they had briefed each other about the shortcomings of the runway that laid ahead of them for the take-off. There was no known evidence that the crew discussed the shorter distance of the runway, which was very crucial for the takeoff.

The Co-pilot, or rather, the Pilot-not-flying, who was supposed to raise the gear up, was apparently conscious, but ceased to perform the tasks for which he was responsible - select the landing gear in the upposition to aerodynamically reduce drag. The Aircraft's Flight Manual instructs that raising the gear up after being airborne would reduce drag and the resultant 'rate-of-climb' would have increased by 200ft/min, which could have augmented the aircraft's performance to clear the first impact at Gwammaja Quarters by, at least, few feet. This was, of course, a breakdown of the crew's co-ordination procedure in the cockpit, because the pilot responsible for raising up the gear had failed to perform his duty. The immeasurable loss of the CVR had deprived AIPB the opportunity of listening to the cockpit's last minutes' utterances and exclamations at this critical moment of the flight.

2.6.7 The Rate of Climb

Even after the runway-end had been overrun, the airplane could still fly away if not for the following two factors: (a) "lack of full engine power" and (b) the landing gear still in the "down position".

(a) Firstly, the airplane ran out of the runway length of 2,600 metres. It, secondly, over-ran the asphalt surfaced blast pad of 60 metres and thirdly, was still on the ground over-running another 150 metres of dry grass vegetations of the approach lights warning lamps, knocking off two of the lamps before getting airborne (Please see appendices 5.9 to 5.11). The flight data recorder would have given these details if one had been available to the AIPB. The only indication to corroborate the overrun evidence was the tire marks impression that was observed on ground, still visible on the day of the accident (Appendices 5.10 and 5.11). This also, gave credence to the evidence given by the Traffic Controller on duty, who said "I was watching the takeoff from the tower and when I saw the great burst of dust on the runway, I knew that the aircraft had over run the end of the runway".

To confirm the 'great burst of dust', AIPB found out at the Rolls Royce Facility where both engines were stripped, that the two turbine engines had acted like "giant vacuum cleaners" and sucked in the dust. The dust was found compressed and compacted in the intercase front flange of the high-pressure compressor casings of both engines (Please see appendix 5.7).

The configuration of the BAC1-11 aircraft was that the engine pylons were constructed at the end of the aircraft fuselage, rearwards of the tire effect. This is not to say that the engine position is an engineering flaw, but the AIPB's previous incidents experience have shown that most of the dynamic airflow effect from the main gear's tires have directed some objects into the engines' air intake area. Sometimes, on a normal takeoff run, even on hard surface runways, objects such as pieces of metals, nuts, bolt and screws have been found ingested by the engines and caused 'foreign object damage' (FOD). These occurrences are well known to airplane operators.

For instance, a BAC1-11 aircraft over-ran the end of runway 19L after heavy rain down pour and ran into a pool of water collection somewhere on the runway. The aircraft was greatly decelerated that the takeoff run was aborted. The aircraft eventually overran onto the

grass area among the approach light arrays. This was an incident but the damage to the engine by the FOD had been done, the engines had to be removed for inspections. AIPB's finding showed that most of the mud and grass thrown rearward from the main tires were ingested and found lodged in the two engines' intake cowl.

In the same vein, both engines of this aircraft ingested most or a substantial amount of the stirred-up dust particle when the dry grassy ground was over run at Kano during this take-off. The after effect of this ingested dust particle, which is not too congenial for the performance of any turbine engine, resulted in the momentary reduction of thrust on both engines, which would cause the climbing aircraft to lose height above ground.

Algebraically taking an inspection look at the theory of engine propulsion will show that, the weight of air taken into the engine for power generation is a function of the number of molecules per cubic foot of the total air intake. The weight of the dust particle mixed with the weight of the air is greatly consequential, because the dust is not a part of this calculation. Sand dust reduces the quantity of the air molecules in the power generation theory. Since thrust is mainly a derivative of 'mass airflow' into the engine intake; less air mass means less thrust:

Thrust =
$$\frac{W_{air}}{g}(V_{exh} - V_{int}) + \frac{W_{fuel}}{g}(V_{fuel})$$

But in this case

$$W_{net air} = W_{air} - W_{dust}$$

.. Net Thrust =
$$\frac{\dot{W}_{net}}{g}(V_{exh}-V_{int}) + \frac{\dot{W}_{fuel}}{g}(V_{fuel})$$

Where Wair = mass airflow into the engine

W_{fuel} = mass of fuel flow into the nozzle

W_{dust} = mass of the dust particles mixed with intake air

 V_{exh} = exhaust velocity coming out from the rear pipe

 V_{int} = mass of air in the intake bell of the engine

Simply stated, the above formula says that the amount of pure air into a turbofan engine is directly proportional to the amount of the thrust out-put.

Less mass of air into the engine, less power thrust out-put from the engine. So, the amount of dust particles ingested through the engine during the grass over-run would result in reduced effect on the engine performance during the takeoff and the aircraft would not be climbing fast enough before reaching Gwammaja Residential buildings. That was one factor for the aircraft's inability to scale through the obstacles in its flight path. This was evident at the stripping facility when the high pressure compressor easing was disassembled. It showed that the compressor really did an efficient job by compressing and compacting the ingested dust particles into a massive cake formation lodged in the crevices of the intercase front flange and high-pressure compressor casings. The total volume of air intake, minus the amount of dust will result in less thrust from the engines.

The second inhibition to the aircraft's fast climb out was the gear down (b) position. On normal circumstances, the pilot-not-flying would have to perform this cockpit duty of raising up the gear, as instantaneously as positive rate of climb is registered on the aircraft's instruments and this is only a couple of seconds after the liftoff. Analysis of the Kano Tower tape transcript (Please see appendix 5.13), suggested that the First Officer was initially on the control column of the aircraft to undertake the Kano-Lagos flight. The voice of the pilot-not-flying, who was on the radio seemed to be that of the commander, who declared at time 1226.35 hours, was heard in his usual jovial manner, on the tower radio: "FL 280 for EXW 4226 ready for space travel". This phrase did not create any conflict, but neither did it show an act of seriousness, professionalism nor is it an acceptable aviation communication lexicon. The aircraft started to roll for the takeoff run at By the time that the crew was aware of the runway end 1228 hours. situation, the commander would have swiftly taken over the control from the First Officer, who would have been so much petrified and demoralized, that he did nothing, instead of assuming the complementary task of assisting the efforts of the Commander, who was trying to salvage the situation from the cockpit. The Co-pilot should have complemented the Commander's effort by selecting the gear lever in the up position to raise the gear. Raising the gear would have saved the situation by increasing the rate of climb of the The Aircraft Flight Manual performance chart states that, the aircraft's climb performance will be reduced by about 150 ft/minute for gear down on a takeoff climb. This penalty was registered on the vertical speed indicator on the instrument panel, which was found at the wreckage site. (Appendix 5.1). The instrument registered a 193 feet per minute rate of descent instead of registering positive rate of climb when the first impact was made with Gwammaja Residential Quarters, the place of the accident.

The FDR would have also corroborated this evidence of the vertical speed indicator.

These are the two major factors, which prevented the faster rate of climb out of ground obstacles for the aircraft after it had overrun onto the grass and dusty end. If the grassy area had been surfaced with asphalt or concrete, there would have been no dust to reduce the thrust output of the engines. AIPB does not consider it necessary to recommend or suggest that the runway be extended, just because of this accident.

2.7 Analysis of a surviving passenger's account.

The eyewitness' evidence is the first-hand on-board account of the accident scenario as given by Mr. Adeshina. He was one of the 4 lucky survivors of the EAS accident in Kano. The evidence is just like a human Flight Data Recorder (FDR), giving the panoramic events of how the accident occurred. The only missing record is the numerical data and the synchronous timing that would have been encoded on the flight data recorder's computer. Mr. Adeshina is an experienced air traveler and he understands, perfectly well, the way an aeroplane flies from the perspective view of an on-board passenger. He was sitting in the mid section of the cabin, at an emergency exit next to the window of the door, So, Mr. Adeshina saw everything, felt every jolt and comprehended the stages of movement of an accelerating aircraft for take-off.

AIPB will now like to analyze every step of this august eyewitness' observation for the purpose of bringing out the probable cause of the unfortunate mishap:

1. The eyewitness described the take-off roll at Kano to be normal until the aircraft crossed the runway 05 thresholds. After that point, he became apprehensive and felt uncomfortable thinking that the aircraft should have been airborne before the threshold marking was overrun by the aircraft.

This proves that the pilots had no component failure indications either from the engine parameters, or any other aircraft system, nor did they have any extraneous compulsion to abort the take-off roll.

2. At a point, Mr. Adeshina noticed that the aircraft had taken-off while the rear tires hit the approach lights structure and <u>serious dusts</u> were raised and the aircraft was distressed and shaken to its foundation. He also noticed that some fluorescent covers on the cabin-ceiling fell to the cabin floor.

From this enumeration, it appears that the eyewitness was aware when the aircraft was rotated ready for the airborne, the nose gear would be off the ground in response to the control column movement, but the main undercarriage was still on ground until the appropriate amount of lift is generated to support the aircraft's weight in the air. After the runway end stop lights (appendix 5.8), the adjacent terrain to the blast pad is the unpaved grassy and dusty space (appendix 5.10), which produced the dust. This observation also agrees with the Air Traffic Officer on duty's evidence who saw a "burst of dust", which indicated to him that the aircraft had overrun the runway.

The aircraft was shaken to its foundation, because it had run into an approach light transformer pit as depicted by the photograph in The product of the aircraft's weight and its acquired appendix 5.11. ground-speed would have inflicted a devastating momentum amounting to between 3-G and 4-G Force, which had rattled the aircraft violently. When the ingested dust began to take effect on the engines, the power output must have been significantly reduced to the effect that the aircraft would begin to lose airspeed and would be approaching a stall. To avoid stalling, the pilot flying must have reduced the angle of attack of the aircraft by lowering its nose to coax more airspeed, at least to sustain the aircraft in a level attitude. Mr. Adeshina observed this aircraft's attitude and described it as "at a stage, I peeped out of the window and discovered that the aircraft was not gaining altitude but relatively stabilized and houses were just few metres below the aircraft."

This altitude (height) was never fully gained until the aircraft started to impact with the buildings and other structures at Gwammaja Quarters.

3.0 CONCLUSIONS

3.1 Findings

- 3.1.1. The British Aerospace Aircraft Group manufactured the BAC-1-11 aircraft in 1980. The company has, since, coalesced to emerge as Airbus Industries PLC.
- 3.1.2 TAROM, Romanian Air Transport was the first Operator to acquire and operate the aircraft in December 1980.
- 3.1.3 The acquisition of the aircraft was transferred to Premi Air Charter and the operation of the aircraft was transferred to the Executive Airline Services Ltd., who registered it in Nigeria in July 2001.
- 3.1.4 The aircraft underwent a full 'D' check and a structural integrity inspection in Romanian in May 2001 before coming onto the Nigerian registry.
- 3.1.5 The aircraft was properly registered in accordance with the Civil Aviation Regulations of the Federal Republic of Nigeria and the Certificate of Airworthiness issued by the Nigeria Civil Aviation Authority was valid until 6th August 2001.
- 3.1.6 The Pilot-In-Command was well qualified to take the flight and was not under any known stress. The day's flight was the 1st flight coming out of a 3 day-duty-rest.
- 3.1.7 The First Officer was also qualified to take the flight. His flying documents were current and up to date.
- 3.1.8 Since the aircraft was committed to full service on arrival in Nigeria, its operation started on the 2nd August 2001 and record showed that the operator properly maintained it.
- 3.1.9 The aircraft became grounded on two occasions. Once on the 16th August 2001 for 11 days because of engine change and some associated problems. It was again grounded on the 9th March 2002 for 52 days because its number 2 engine developed 'vibration and loss of power problems'. ESF then resumed flying on the 2nd May and crashed on the 4th May 2002.

3.1.10 On the day of the accident, the aircraft was engaged in a scheduled passenger service enroute Lagos-Jos-Kano-Lagos and crashed on take-off from Kano at the commencement of the last segment of the

- 3.1.11 Both the aircrew and the maintenance crew of most Nigerian Operators have not been observing the importance of using the aircraft technical logbook.
- 3.1.12 Available record showed that the aircraft was equipped with a Collins CVR Model 642C-1, P/N 522-4057-002. But the CVR could not be recovered despite a thorough search for many days at the crash site.
- 3.1.13 The FDR was changed on the 18th November 2001 with another one Serial Numbered 2027 removed from 5N-ESD. However, no useful information could be obtained from the FDR. The data retrieved did not correlate with any runway orientation, or any flight in Nigeria.
- 3.1.14Entries validating the daily inspection record of the FDR and the CVR were not made in the aircraft Technical Logbook nor did the EAS staff maintain a separate daily inspection sheet record.
- 3.1.15 The wreckage examination revealed that the under-carriage (landing gear) was in the extended position and that the flap was selected in 20⁰ extended position.
- 3.1.16 The weight of the aircraft was within the prescribed limit. The aircraft's actual take-off weight was 39,243kg while the designed maximum allowable take-off weight of the aircraft was 47,400kg.
- 3.1.17The aircraft had 77 souls onboard (69 passengers plus 8 members of crew) and the Commander signed the prepared load-sheet, whose illustration of center of gravity was within the prescribed envelope.
- 3.1.18The longer runway 06/24 was NOTAMed closed to flight operations from midnight 1st April 2002 to midnight 1st October 2002. Runway

- 05/23 was opened but limited to B-767 and maximum all-up weight of 156.49 tons
- 3.1.19Runway 05/23 in use for landings and take-offs at Kano airport is 2,600m long by 45m wide and was found to be adequate for the successful take-off of the aircraft on the day of the accident.
- 3.1.20 The airframe structure and the aircraft engines did not fail prior to the Impact with the Gwammaja Residential Quarters in Kano Metropolitan area on the flight path of runway 23.
- 3.1.21 There was no sign of asymmetric thrust to indicate that an engine had failed prior to lift-off, because of the aircraft's keeping the runway center line at the 125knots. Otherwise, it would have veered off to runway shoulder.
- 3.1.22For some unknown reasons, the pilots did not put corrective actions
 In place to stop the aircraft from over running the end blast pad onto the dusty grass among the runway 05 approach lights of Mallam Aminu Kano International Airport, Kano.
- 3.1.23 The aircraft's takeoff roll onto the dusty grassy path which it was not intended for generated a lot of cloudy dust which the two engines ingested, thereby losing power immediately after getting airborne.
- 3.1.24 After getting airborne without any structural damage, the aerodynamically unclean aircraft, with its landing gear extended, combined with its loss of power to climb, caused it to lose 193 ft/min rate of descent and impacted with Gwammaja Quarters' mud houses, which were either destroyed or set on fire by aviation fuel.
- 3.1.25 The surging and uncontrollably huge number of crowd greatly inhibited and compounded the rescuer's effort and the Accident Investigator's preliminary investigations.
- 3.1.26The ICAO Expert's audit of the NCAA reveals that the Airworthiness Component of NCAA was not effective, in that, out of 26 Field Airworthiness Inspectors, 10 have no aviation background and that no airworthiness surveillance plan was in force. Additionally, the

Maintenance practice of Messrs EAS needed considerable improvement in many areas.

- 3.1.27 The NCAA airworthiness Department has a ramp inspection plan, but it does not have a detailed surveillance inspection plan that would cover all airworthiness activities.
- 3.1.28The Federal Republic of Nigeria contains about 35 Aircraft Operators and more than 160 registered aircraft of different types. The diversity in the large number of operators having some peculiar organizational safety culture and, a great diversity in the types of aircraft registered combined to the meagre qualitative and quantitative resources of airworthiness inspectors undermining the safety at large.

3.2.0 The Probable Cause of the Accident

The probable cause of the accident was the crew's inability to get the airplane airborne within the safe parameter of the available runway length.

The contributive factor was the breakdown of the crew's cockpit coordination procedure in executing a coercive reaction of initially, (i) getting the aircraft airborne; (ii) improving its climb performance by raising up the gear and (iii) flying the airplane to safe height before thinking of the next line of action.

4.0 Safety Recommendations

- Based on the AIPB's findings that Pilots are in the habit of losing their flying documents in the course of their career, it is recommended that NCAA should constitute or set up a machinery for investigation of this "malpractice" with a view to insure that such losses are reduced or prevented. In the course of NCAA investigation into this matter, anyone found culpable should be appropriately sanctioned for abuse or falsification of record.
- Attendants at MAKIA on the day of the accident, AIPB recommends that in emergencies or accident occasions, all airport tenants and vendors should be under the effective supervision of the Airport Authority and be ready to take directives from same, pending the completion of the Preliminary Investigation. In addition, the Airport Authority of Nigeria should oversee the activities of Aviation Fuel supply at airports and in the event of accidents, this authority should be present at the fuel sample taking for the purposes of further investigation into the course of the accident.
- 4.3 For aviation fuel Quality Control purposes, it is recommended that NCAA may establish an inspectorate department, which will always supervise aviation fuel standards in general.
- Stiffer penalties should be imposed on pilot or operator who is found in default of the established procedures in the use of Flight Recorder.
- 4.5 It is also recommended that all flight data recorders installed on any Nigerian registered aircraft must be a Digital Flight Data Recorder (DFDR). Nigerian Civil Aviation Authority should not register an aircraft, which is not fitted with Digital Flight Data Recorder.
- 4.6 Aircraft Flight Manuals (AFM) and all Aircraft Maintenance Schedules (M/S) are peculiar to the specific aircraft serial number. It is accordingly recommended that the NCAA should review all operators' Maintenance Schedules to ensure that they are appropriately customized and up to date.
- 4.7 NCAA should employ personnel knowledgeable in aircraft maintenance to perform airworthiness surveillance.

NCAA to regularly audit the activities of aircraft operators, should also put the appropriate machinery in place to enable the authority to perform this task.

4.8 Finally, NCAA should immediately conduct an audit of all BAC1-11 aircraft on the Nigerian Registry to ensure that only operators, who have the maintenance facility, support and bonded spare part stores in the country or those who have external spare part support arrangement, should be allowed to operate the BAC1-11 type of aircraft in the country. The practice of keeping one non-airworthy aircraft on ground to be cannibalized in order to keep others in the fleet flying should be discontinued.

5.0 Appendices

- A portion of the instrument panel retrieved from the accident site.
- 5.2 Picture showing damage done to the Inlet Guide Vane (IGV) of the engine No.1.
- 5.3 Picture of the No.2 engine showing a relatively undamaged IGV.
- 5.4 A close-up pictorial view of Gwammaja Quarters' houses destroyed in the accident.
- 5.5 A section of Gwammaja Quarters' street, which was mostly affected by the disaster.
- 5.6 An assisting NTSB Accident Inspector from Washington DC. Inspecting an engine before preservation and packaging for shipment.
- 5.7 Magnified picture of the intercase front flange of the high pressure casing to depict where the compacted dust lodged.
- 5.8 Photograph of the runway-end-stop light and the beginning of the unpaved path.
- 5.9 Picture showing the blast pad and the knocked off stop light lamp
- 5.10 Photograph showing the tire marks of the aircraft on the dusty terrain.
- 5.11 The aircraft's tire ran over the approach light transformer pit.
- 5.12 The layout plan of Mallam Aminu Kano International Airpor showing runway 05/23, runway 06/24 and the location of Gwamma Quarters.

- 5.13 A copy of Kano Tower tape transcript
- 5.14 Photocopy of the *Certificate of Release to Service*. Issued by the engineering and maintenance dept of TARON, Bucharest, Romania.
- 5.15 The cover page of mandatory Supplemental Structural Inspection Document listing of number of inspections performed on the aircraft in July 2001.
- 5.16 The photocopy of the Certificate of Compliance
- 5.17 Photocopy of the Mandatory Aircraft Modifications and Inspection.List.
- 5.18 The statement of all the embodied Service Bulletins (SB's) and Service Letters
- 5.19 Copy of the Mandatory Aircraft Modification and Inspection Performed on this particular airplane.



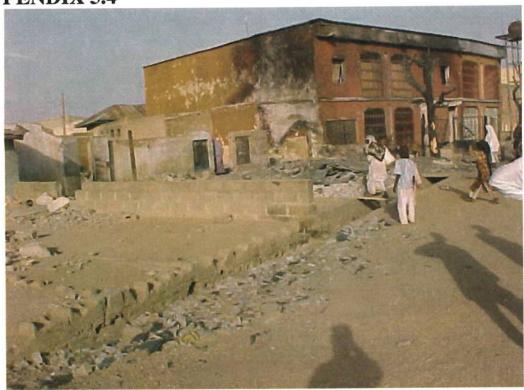
A portion of the instrument panel retrieved from accident site.



The damaged Inlet Guide Vane (IGV) of engine # 1



Engine No.2 showing relatively an undamaged IGV.



A close view of the Gwammaja Quarters' house destroyed in the accident.



A section of Gwammaja Quarters mostly affected by the disaster.



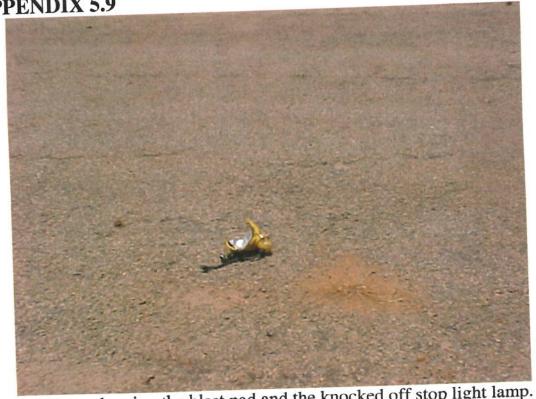
Mr. Dennis Jones from the NTSB inspecting the engines before preservation and packaging for shipment.



Magnified picture of the intercase front flange of the high-pressure compressor casing to depict where the compacted dust lodged.



Photo of the Runway End Stop lights and the beginning of the unpaved path.



Picture showing the blast pad and the knocked off stop light lamp.



Photograph showing the tire marks of the aircraft on the dusty terrain.



The aircraft's tire ran over this depression, which is deep enough to Inflict serious damage to the aircraft's primary structure.