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بسم الله الرحمن الرحيم

UNITED ARAB EMIRATES

GENERAL CIVIL AVIATION AUTHORITY

OFFICE OF THE DIRECTOR GENERAL

دولة الإمارات العربية المتحدة

الهيئة العامة للطيران المدني

مكتب المدير العام

AIRCRAFT ACCIDENT 2/01

FINAL REPORT ON THE ACCIDENT INVOLVING PAKISTAN INTERNATIONAL AIRLINES AIRBUS A300-B4, AP-BCJ AT DUBAI INTERNATIONAL AIRPORT, UNITED ARAB EMIRATES ON 17 OCTOBER, 2001

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REPORT DATE: 01 FEBRUARY, 2003

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ABBREVIATIONS USED IN THIS REPORT

agl	Above Ground Level
amsl	Above Mean Sea Level
ATC	Air Traffic Control
BE-A	Bureau Enquêtes-Accidents
CAA	Civil Aviation Authority (Pakistan)
CEAT	Centre d'Essais Aéronautique de Toulouse
cm	centimetre(s)
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
GCAA	General Civil Aviation Authority (UAE)
ft	Feet
h	hour(s)
hPa	Hectopascals
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
kg	Kilogram(s)
km	Kilometre(s)
kt	Knots
m	Metre(s)
M	Magnetic (heading)
MHz	Megahertz

min	Minute(s)
mm	Millimetre(s)
nm	Nautical Mile(s)
PA	Public Address System
PF	Pilot flying
PNF	Pilot not flying
QNH	Setting on altimeter sub scale to indicate altitude above mean sea level
sec	Second(s)
SOP	Standard Operating Procedure(s) (operator)
UAE	United Arab Emirates
UTC	Coordinated Universal Time
VMC	Visual Meteorological Conditions

INTRODUCTION

1. The aircraft involved was an Airbus A300-B4, owned by the Pakistani national carrier Pakistan International Airlines, based in Karachi, Pakistan. Pakistan was the State of Registry and the State of the Operator and France was the State of Design and the State of Manufacture. On this particular flight, PK 231, AP-BCJ, was operating a scheduled passenger flight from Peshawar, Pakistan to Dubai, UAE, and was landing at night at Dubai International Airport on runway 12 L.

2. The aircraft was observed by the Dubai ATC Tower Controller to land normally. As the aircraft decelerated, a shower of sparks was seen and the crash alarm was activated by ATC. The aircraft came to a stop off the runway and all passengers and crew members were evacuated using the emergency slides.

3. The accident details are as follows;

Registered Owner	:	Pakistan International Airlines
Registered Operator	:	Pakistan International Airlines
Aircraft type & model	:	Airbus A300-B4
Nationality	:	Pakistani
Registration	:	AP-BCJ
Place of Accident	:	Dubai International Airport, United Arab Emirates Runway 12 L Latitude : 25° 15' 03" N Longitude : 055° 21' 40" E
Date & Time	:	17 October, 2001 0208 hours local UAE time 16 October, 2001 2208 hours UTC

Note: Unless otherwise stated, all times in this report are local UAE time, which is Coordinated Universal Time (UTC) plus 4 hours.

Injuries	:	21

4. The runway was closed and the GCAA was notified shortly afterwards. The following GCAA personnel were nominated to the Aircraft Accident Investigation Committee under a Ministerial Decree.

Eng. Ahmed Al Haddabi - Investigator-in-charge
Director Flight Safety

Eng. Mohammed Abu Baker Al Farea Chief of Airworthiness	-	Investigator on airworthiness matters
Mr Waleed Mohammed Ghanim Safety & Security Inspector	-	Investigator on cabin safety and security matters
Captain Philip J. Smith Chief Flight Operations	-	Investigator on flight operational matters

5. An official from the Bureau Enquêttes-Accidents of Paris, France, representing the State of Design and State of Manufacturer, as well as an official from the Pakistani Civil Aviation Authority (CAA), were granted accredited representation. Technical advisers from the CAA, manufacturer and airline also assisted in the investigation and were granted observer status.

6. 6 safety recommendations have been made.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 The aircraft was operating as a scheduled flight from Islamabad via Peshawar, Pakistan to Dubai, UAE with the Captain as the pilot flying (PF). The crew reported nothing unusual for the take-off at Peshawar and the aircraft operated to Dubai without event. The accident occurred after landing on Dubai runway 12L. The aircraft was operated in a dedicated passenger configuration as flight PK 231 and the radio call-sign was "Pakistan 231".

1.1.2 At 0202 hours local time, the aircraft was radar vectored by Dubai Approach Radar for the Instrument Landing System (ILS) for runway 12L at Dubai International Airport. The aircraft was vectored to a downwind position on a heading of 300° M during a descent to 2000 ft. After the crew advised that they could accept an early base turn, ATC vectored the aircraft for the localiser intercept and instructed the aircraft to report established on the localiser for Dubai runway 12L. Once the crew acknowledged this instruction, with the aircraft at 7 nm, ATC then cleared the aircraft for the ILS approach and instructed PK 231 to call Dubai Tower.

1.1.3 The aircraft was observed by ATC Tower personnel to be stable in heading and height on the approach and landed normally. Approximately halfway down the runway the ATC Tower controller observed a shower of sparks coming from the right hand side of the aircraft and activated the crash alarm. The aircraft initially slid along the runway on the left and nose landing gear with the right engine in contact with the ground. The aircraft then left the runway onto the unprepared surface and came to rest heading 194° in soft sand. A major fuel leak emanated from the fuel tank above the damaged right landing gear, which had collapsed rearwards.

1.1.4 The Captain initiated an evacuation and all passengers and crew were evacuated safely. During the evacuation the fire and rescue services blanketed fuel spillage and assisted the passengers. The runway was closed and all inbound traffic diverted to regional aerodromes.

1.2 Injuries to persons

There were 21 passengers who sought medical treatment from the Dubai Airport Clinic. Treatment ranged from minor bruising as a result of the evacuation to shock. All treatment was considered as being extremely minor and no passenger required hospitalisation or further treatment. For the purpose of this report all passengers who sought medical treatment were classed as injured.

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor	0	21	0

1.3 Damage to aircraft

1.3.1 General.

The right landing gear collapsed rearwards when the aircraft was decelerating along the runway. As it collapsed, the right engine and right flap tracks contacted the runway and were damaged. As the aircraft left the runway onto the unprepared sandy surface, the right engine was further damaged and pushed upwards into the leading edge of the wing.

1.3.2 Fuselage.

The fuselage was generally undamaged except for a 40 cm wide scrape on the lower fuselage 2.5 m either side of the rear cargo hold door and slightly right of the fuselage centreline.

1.3.3 Engines.

The lower section of the right engine suffered scraping damage and the engine was then further damaged by impact with the unprepared sandy surface. The engine did not separate from the wing but was forced upwards into the pylon and wing leading edge. The left engine was undamaged.

1.3.4 Wings.

The leading edge of the right wing was damaged by the right engine and the leading edge slats were forced back to their retracted position. The flap tracks on the right wing all suffered scrape damage after contact with the runway surface and sand. The right inboard trailing edge flaps were damaged by the wheels of the collapsed right landing gear. There was evidence of damage to the wing tank above the right landing gear. The left wing was undamaged.

1.3.5 Landing Gear.

1.3.5.1 Nose. The nose landing gear was intact however it had been forcefully turned through 90° as the aircraft moved through the soft sand.

1.3.5.2 Right Main. The right main landing gear had collapsed rearwards and the hinge arm was broken. The down-lock was still attached in the locked position.

1.3.5.3 Left Main. The left main landing gear was undamaged.

1.4 Other damage

There was damage to two runway 12L centreline lights and a taxiway sign was destroyed.

1.5 Personnel information

1.5.1 General.

The required flight crew complement for the Airbus A300-B4 was a Captain, First Officer and Flight Engineer.

1.5.2	Captain	:	Pakistani National Male aged 51 years		
	Licence	:	ATP Licence valid until January 2002 A300 command type rating		
	Medical Certificate	:	Valid until 31 January, 2002		
	Flying experience	:	Total all types	-	13992.68 hours
			Total on A300	-	2007.96 hours
			Last 30 days on A300	-	48.61 hours
			Last 24 hours on A300	-	2.74 hours
	Duty Times	:	Last 30 days	-	85.32 hours
			Last 7 days	-	11.19 hours
			Last 24 hours	-	5.25 hours
	Training	:	A300 type rating	-	03 July, 1998
			Line Check	-	22 June, 2001
			Pilot Proficiency Check	-	29 June, 2001
1.5.3	First Officer	:	Pakistani National Male aged 46 years		
	Licence	:	ATP Licence valid until March 2002 A300 co-pilot type rating		
	Medical Certificate	:	Valid until 30 November, 2001		
	Flying experience	:	Total all types	-	4235.03 hours
			Total on A300	-	1407.19 hours
			Last 30 days on A300	-	41.40 hours
			Last 24 hours on A300	-	2.74 hours
	Duty Times	:	Last 30 days	-	67.04 hours
			Last 7 days	-	11.25 hours
			Last 24 hours	-	5.25 hours
	Training	:	A300 type rating	-	28 September, 1998
			Pilot Proficiency Check	-	19 September, 2001

1.5.4	Flight Engineer	:	Pakistani National Male aged 49 years		
	Licence	:	F/E Licence valid until January, 2002 A300 type rating		
	Medical Certificate	:	Valid until 31 January, 2001		
	Flying experience	:	Total all types	-	14440.87 hours
			Total on A300	-	6021.94 hours
			Last 30 days on A300	-	35.26 hours
			Last 24 hours on A300	-	2.74 hours
	Duty Times	:	Last 30 days	-	61.18 hours
			Last 7 days	-	7.49 hours
			Last 24 hours	-	5.25 hours

1.6 Aircraft Information

1.6.1 Aircraft Details

Type	:	Airbus A300-B4
Serial No.	:	268 manufactured in July, 1983
Engines	:	General Electric CF6-50 C2
Certification of Registration	:	Registered in Pakistan as AP-BCJ
Certificate of Airworthiness	:	Issued 22 May, 2001; Valid to 21 May, 2002
Total airframe hours	:	48580 hours
Total cycles	:	25010 cycles
Actual Zero Fuel Weight on departure	:	116.346 tonne
Actual traffic load on departure	:	23.187 tonne
Fuel on board on departure	:	26.3 tonne
Maximum Fuel	:	47.5 tonne
Actual TOW on departure	:	142.646 tonne
MTOW	:	165 tonne
Actual landing weight on arrival	:	121.346 tonne
MLW	:	136 tonne

1.6.2 Maintenance Details.

Maintenance performed in accordance with the manufacturer's Maintenance Schedule for Airbus A300-B4.

Date of last inspection	:	"A" Check conducted 27 September, 2001
Next maintenance review	:	49511.25 hours

1.6.3 Technical Considerations.

The aircraft maintenance documents indicated that the aircraft had no carried over defects since the last daily inspection on 16 October, 2001. The aircraft was serviceable at the initial departure aerodrome of Islamabad and two further defects were reported at Peshawar; one a bird strike and the other a minor instrument problem, which allowed the aircraft to be dispatched under the operator's Minimum Equipment List.

1.6.4 Right Landing Gear Information

The right main landing gear was Part No. C23094-525; Serial No. B124. It had a total number of 26653 landings since new and 1665 landings since the last overhaul by Pakistan International Airlines on 03 August, 2000. There were no recorded defects or unscheduled maintenance since overhaul.

1.7 Meteorological Information

1.7.1 General.

There was a general forecast of a weakening high pressure gradient covering the lower Arabian Gulf with no low level instability expected. The actual weather at the time of the incident was fine and slightly hazy with light winds.

1.7.2 Facilities.

The UAE forecasting centre is located at Abu Dhabi International Airport and it has a comprehensive meteorology section with modern calibrated instruments and recording facilities. The Dubai Airport meteorological instruments were calibrated within the previous 12 months and were serviceable at the time of the incident.

1.7.3 Weather Conditions.

1.7.3.1 Dubai Weather Report (Forecast). The forecast issued at 161400 hours UTC was for fine and clear conditions with light winds.

1.7.3.2 Dubai Weather Report (Actual). The weather conditions recorded at 2152 hours UTC (16 minutes before the accident) and at 2221 hours UTC (13 minutes after the accident), were;

		2152 hours UTC		2221 hours UTC
Wind	:	Variable 3 kt	:	140/03 kt
Visibility	:	> 10000 m	:	>10000 m
Cloud	:	nil	:	nil
Temperature	:	26° C; Dewpoint 18° C	:	26° C; Dewpoint 18° C
QNH	:	1011 hPa	:	1011 hPa
Warnings	:	Nil	:	Nil

1.8 Aids to Navigation.

The navigation aids at Dubai are NDB, VOR/DME as well as an ILS for each runway. They conform to, and are in compliance with, Annex 10, Volume 1, Radio Navigation Aids. The runway 12L ILS was operating on 110.10 MHz and was flight checked on 27 August, 2001. There was no known unserviceability or abnormality prior to the incident and a functional check was conducted shortly after the incident, which confirmed normal operation.

1.9 Communications.

All transmissions to the aircraft, as well as inter-agency telephone conversations, made by UAE ATC were clear, in the English language, and recorded. Transcripts were made of all communications involving PK 231 and the initial emergency response. There were no transmissions made by PK 231 indicating a problem and all conversation was given in a clear and unhurried manner. The co-pilot was subsequently determined to have made all communications to ATC from PK 231, and during those transmissions, no aircraft warning noises were heard. There was no transmission made on the recorded distress frequency of 121.5 MHz. The UTC timing on the tapes was determined to be correct UTC time. (Refer to Attachment 1 for transcript). As all instructions issued by ATC were correctly acknowledged, radio communications between ATC and PK 231 were not considered a factor in this accident.

1.10 Aerodrome Information.

1.10.1 Air Traffic Control.

Dubai International Airport is a UAE international airport with two parallel runways. Runway 12L is aligned at 122° M and dimensions are 4000 m x 60 m with full facilities. At the time of the incident the control tower was manned by correctly licensed and validated personnel. For ILS operations, Dubai Approach Control vector aircraft onto the localiser in accordance with Local Air Traffic Services Instructions.

1.10.2 Fire Services.

Dubai Airport Fire Services are categorised as Rescue and Fire Fighting (RFF) Category 9. The RFF facility was determined to be operating to RFF Category 9 at the time of the incident.

1.11 Flight recorders

1.11.1 Recovery.

The Cockpit Voice Recorder, a Fairchild Model A100, S/N : 6470, and the Digital Flight Data Recorder (DFDR), a Sundstrand Model 6009, S/N 2347 were retrieved from the aircraft and presented to the Bureau Enquetes-Accidents in Le Bourget, France on 22 October, 2001 for extraction of the DFDR data and CVR transcription.

The extraction of the data and transcriptions were witnessed by the GCAA Incident Investigation Team and other technical observers.

1.11.2 Cockpit Voice Recorder.

1.11.2.1 General. A satisfactory replay was obtained, which covered the conversations between crewmembers in Urdu and English, communications with Dubai ATC in English and general cockpit sounds. The 36 minute duration recording was a good quality recording on 4 separate tracks. The replay commenced during the aircraft's descent to FL 200 and ended during the latter phase of the evacuation. The crew is heard to conduct the approach and landing in accordance with SOPs although an incorrect QNH of 1012 hPa was set, instead of 1011 hPa as stated on the ATIS and advised by ATC. A full transcript was made commencing from the downwind leg until after the aircraft came to rest and a partial transcript was made until the tape finished to assist in the evacuation analysis. (Refer to Attachment 2 for full transcript).

1.11.2.2 Landing Gear Extension. The landing gear extension was clearly heard on the replay including abnormal sounds, which were heard by the crew and passengers. The sounds heard were as follows;

CVR UTC Time			Comment
22 h 03 min	23.17 s	-	"Gear Down" command by Captain
	24.26	-	Landing gear lever click as lever is initially moved
	25.11	-	Landing gear lever click as lever is fully down
	25.16	-	Wind noise as landing gear doors open
	31.11	-	Unidentified click
	31.21	-	Unidentified click
	31.94 – 32.00	-	Thud sound with four distinct noises
	33.22	-	"Oh" by Captain

1.11.2.3 Final Approach and Landing. The thud sound was immediately followed by crew conversation regarding this unusual sound. The Purser was heard to enter the cockpit and inform the crew of the loud noise heard in the cabin and of some passenger concerns. Shortly after the final flap selection was made, the Flight Engineer was heard to call "gear green" and then "green hydraulics" as the green hydraulic system failed. The crew discussed the possible problem and believed it may have been nose wheel related. They are heard to discuss the requirement for an additional 5 kt decrement as required by the checklist. The Captain told the crew that they will continue the approach and he will hold the nose wheel off after landing. The landing and initial landing roll was heard to be normal and the Flight Engineer was heard to call that they gear was still green and for the Captain not to lower the nose wheel too early.

1.11.2.2 Right Landing Gear Collapse. The Flight Engineer called "80 knots" and almost immediately afterwards there was a loud scraping noise heard. The Captain was heard to say that it wasn't the nose wheel after all. Before the aircraft stopped, the First Officer requested ATC to send the emergency services.

1.11.2.3 Evacuation. As soon as the aircraft stopped, the Captain commanded the on-ground emergency evacuation checklist. The evacuation sequence was heard as follows;

UTC Time		Comment		
22 h	08 min 40 s	Standby for evacuation	-	Captain over PA
	56	At your stations	-	First Officer
	56	Cabin crew....Cabin crew at your stations for evacuation	-	Captain over PA
	09 min 31 s	Evacuation – Initiate	-	F/E from checklist
	32	Cabin crew....	-	Captain over PA
	43	Cabin crew....	-	Captain over PA
	49	Cabin crew, initiate evacuation from right side	-	First officer
	50	Cabin crew, please start the evacuation from the right hand side	-	Captain
	10 min 05 s	Evacuation signal commences		
	28	Door is not working....slide is not there	-	Female cabin crew
	29	Open the others, open the others, open the other side	-	Captain
	32	Use other side!	-	Female cabin crew
	38	Use any slides	-	Captain
	57	Evacuate from left hand side, left hand side	-	Captain over PA
	11 min 05	Go to the rear (to F/E)	-	Captain
	14	Chute is not inflating	-	First officer
	14	Sound of L1 door inflating		
	15	Go....go	-	Evacuation
	26	Relax, relax, everybody relax	-	Captain
	26	Wait a minute, wait a minute	-	Purser
	30	Take the torches out	-	Captain
	30	You go back and control them, everybody out with torches	-	Captain
	38	Everything is all right, everything is all right, nothing to worry	-	Captain
	48	Remove the shoes	-	Captain
	48	Start evacuation	-	Captain
	53	Start evacuation	-	Captain
	54	Leave the baggage	-	Captain
	58	Leave the baggage	-	Captain
	12 min 06 s	Start evacuation	-	Captain

1.11.3 Digital Flight Data Recorder.

A satisfactory extraction of the data was obtained and the following important information was extracted. The DFDR indicated that the landing gear lever was selected to the down position at 22 h 03 min 25 s (UTC). The right landing gear was down and locked at 22 h 03 min 33 s as indicated by lateral and longitudinal accelerations oscillating for about 2 seconds. Whereas the nose and left landing gear are down and locked at 22 h 03 min 38 s and 22 h 03 min 39 s (UTC) respectively and there are no oscillations of the accelerations at these times. When the aircraft landed at Dubai at 22 h 07 min 56 s (UTC) as determined from the compression of the left and right landing gear, the DFDR data indicated that the right landing gear was not "Down and Locked". However, this could not be correct as the roll angle was null. At 22 h 08 min 12 s (UTC), the nose landing gear was compressed and the roll angle became positive up to 11 degrees, indicating that the right wing went down. The right and left landing gear were both retracted simultaneously after takeoff at Peshawar at the commencement of this flight. They were also extended simultaneously during the approach into Peshawar on the previous flight. (Refer to Attachment 3 for DFDR graphs)

1.12 Wreckage And Impact Information

The first impact information was a series of gouges found on the runway surface from 1395-1575 m from the runway 12 L end. Pieces from the right landing gear hinge arm were found on the runway from 1515-1530 m and 1590 m from the runway 12 L end. The aircraft touch-down tyre marks on the runway were not determined. The first identifiable tyre mark was at 2230 m where the right landing gear twisted inwards and backwards. The second mark was a green paint scrape on the runway centreline at 2250 m where the aircraft fuselage touched momentarily. These were shortly followed by right wing flap and right engine scrapes. The aircraft left the runway edge at 2505 m and came to rest at 2700 m heading 210° M. (Refer to Attachment 6)

1.13 Medical Information

Investigation of the crewmembers' medical history confirmed that they met the GCAA and ICAO Annex 1 medical standards for the licences held. There were no indications of any disorder that could have had a bearing on this accident.

1.14 Fire

Not applicable.

1.15 Survival Aspects

Survivability was enhanced mainly by the lack of any fire, since most of the fuel in the right wing had leaked and formed a lake under the forward section of the aircraft. Had there been a fire, it is probable that numerous fatalities would have resulted. The cabin crew members only commenced the evacuation after the command from the Captain, which was 80 s after the aircraft came to rest. It was determined that the evacuation from the aircraft did not commence for at least a minute after the Captain's initial evacuation command.

The R1, R2, R3, R4, L2 and L4 slides did not function correctly and all passengers and crew evacuated through the L1 and L3 doors only. The fire fighting trucks arrived just after the aircraft came to rest and were spreading foam on the engine and fuel spillage whilst the majority of the passengers were still evacuating. In addition, as the aircraft was just off the runway, the fire services had no difficulty reaching the aircraft. The prompt action by the ATC Tower controller to activate the crash alarms and the immediate response by the fire fighting and rescue services would have greatly contributed to the survivability of the passengers and crew had the aircraft caught fire.

1.16 Statements

1.16.1 Captain's Statement.

1.16.1.1 The Captain stated that he was occupying the left seat and was the pilot flying (PF). He stated that the aircraft was duly certified as serviceable for the flight from Peshawar to Dubai and that the flight was uneventful. He recalled that there was nothing unusual regarding the departure from Peshawar and the landing gear retracted normally. He was radar vectored for the downwind position to Dubai runway 12L and opted to turn base earlier than normal as there was another Pakistan International Airlines aircraft following. He requested the selection of slats 16° followed by the landing gear at about 215 kt and an altitude of 2300 ft. When the landing gear was being extended, he heard an abnormal sound associated with the landing gear. He did not notice the order of the transit or down indications but felt the left may have gone down first. The Purser entered the cockpit and advised him that the sound was heard in the cabin as well. He stated that he crosschecked the landing gear indications and both the pilot and flight engineer consoles were indicating green for all wheels. He then requested the selection of the remaining three stages of flap in quick succession and disconnected the autopilot as he was above the glide slope. The Flight Engineer then advised him that the green hydraulic system had failed and to add 5 kt to the threshold reference speed (V_{REF}), which then became 136 kt. The Captain then announced his intention to land and to hold the nose wheel off the runway for as long as possible. Autobrakes were not selected. He stated that the touchdown was smooth and reverse thrust operated normally and the aircraft decelerated normally without the use of brakes. At around 85 kt he noticed the aircraft tending to veer right and he attempted to correct this with left brake and rudder but without success. He heard an abnormal sound as if a tyre had failed and this sound continued until the aircraft came to a stop on the sand at the edge of the runway.

1.16.1.2 As soon as the aircraft stopped he recalled requesting the emergency evacuation checklist and shortly after heard the ATC advising another station that his aircraft had a fire on the right hand side. Shortly after he had commanded the evacuation the Purser entered the cockpit and advised him that the R1 and R2 door slides were not working. He stated that he then ordered the evacuation from the left exits and once again the Purser advised him that some left hand slides were not working. He therefore left the cockpit to supervise the evacuation from the L1 door. He had previously sent the First Officer to the L3 door and he returned to advise that the evacuation from L3 was completed. Even though L2 and L4 door slides did not operate these exits were manned throughout the evacuation. He recalled that all crewmembers were calm and carried out their required duties.

1.16.1.3 Once the toilets and cabin were re-checked by the cabin crew, he ordered the Flight Engineer to turn off the battery and he evacuated through the L1 door.

1.16.2 First Officer's Statement.

1.16.2.1 The First Officer stated he was the pilot not flying (PNF) and that the flight from Peshawar to Dubai was uneventful. He recalled that when the landing gear was lowered there was a loud unusual noise heard although no abnormal indication was observed in the cockpit. After flaps were fully extended the "hydraulic" light illuminated on the Master Warning Panel. He recalled that the Flight Engineer advised that the hydraulics were lost so the appropriate emergency checklist was conducted. A normal landing was then made. At 80-85 kt he noticed the right main landing gear indicator went red and announced it. At the same time he noticed the aircraft veering to the right and felt the aircraft shudder. He realised that a landing gear had collapsed. The aircraft then left the runway.

1.16.2.2 The Captain called for the on ground emergency evacuation checklist and he selected the emergency lights to the on position. He then advised ATC to send the fire services but had to call them again. He stated that after the checklist actions had been completed the Captain commanded him to assist in the passenger evacuation. As he made his way down the cabin he noticed that passengers were endeavouring to take their carry on bags with them and the Captain and Purser were instructing them to leave it behind. He found L2 door slide was inoperative so he instructed passengers to evacuate through L1 door. He recalled that the fire services had arrived whilst passengers were still evacuating. After the evacuation was completed he left through L1 door.

1.16.3 Flight Engineer's Statement.

1.16.3.1 The Flight Engineer stated that when the landing gear was lowered there was an unusual loud thud noise. He checked the gear indications and noticed that the required green indications were on the centre instrument panel and on the Flight Engineer's panel. When flaps were selected to 25° at about 1500 ft the hydraulic warning illuminated and he noticed that the green system hydraulic quantity was in the yellow range. He informed the Captain and conducted the relevant checklist actions. He recalled that the touchdown was smooth. At about 100 kt during the landing roll he noticed that the green light for the right landing gear went out although it was still illuminated on his panel. At 85 kt the green light for the right landing gear also went out on his panel and the aircraft started to yaw to the right. He believed that the aircraft left the runway at about 60 kt.

1.16.3.2 After the aircraft stopped he carried out the on ground emergency evacuation checklist and the cabin crew were informed to evacuate the aircraft. He recalled that the Purser entered the cockpit to advise that the R2 door slide would not operate and he was advised by the Captain to use the left doors. He stated he was requested by the Captain to go into the cabin to assist the evacuation of passengers and was told by the cabin crew that only L1 and L3 door slides were working. After the evacuation was complete he left the aircraft through the L1 door.

1.16.4 Senior Purser's Statement.

The Senior Purser was seated at the front left door (L1) and heard an unusual and loud noise and felt the aircraft moving in a zigzag line as the landing gear was lowered. Numerous passengers also complained about this noise so he entered the cockpit and advised the flight crew. He stated that the aircraft subsequently landed safely. However during the landing roll the aircraft went into a skid and when it stopped, it was inclined to the right. He recalled that when the aircraft stopped, the Captain commanded cabin crew members to evacuate passengers from the right side of the exit doors. Shortly afterwards the Captain commanded that only the left exit doors should be opened. During the emergency evacuation, the L2 and L4 exit doors slide failed to deploy and thus the passengers were only evacuated through L1 and L3 doors. The senior purser reported to him that although L2 door opened freely, the escape slide was folded over creating a barrier and was not usable. He also mentioned that the L4 door was not operated because the slide completely failed to deploy. During the evacuation he recalled that the senior purser shouted out commands to direct passengers to evacuate from L1 & L3 exits. He believed that the individual cabin crew members were assertive and calm and were able to accelerate passengers movement to and through an exit. The stated that he thought that all passengers were successfully evacuated within ninety seconds. During the evacuation he requested regular inspections to be conducted by cabin crew to ensure that all areas were free of obstruction on exit paths and exit doors.

1.16.5 Other Cabin Crew Member's Statements

Statements were taken from all other cabin crew members manning an exit door. Their statements were all very similar and avoided the question of why the right hand exits were not deployed even though it was 38 seconds after the initial command to evacuate from the right side until the Captain ordered the evacuation from the left side.

1.16.6 ATC Tower Controller's Statement.

The ATC Controller, who was on duty in the tower located approximately half way along the runway, reported that the aircraft appeared to make a normal landing. Shortly after touchdown he noticed sparks and smoke coming from the right side of the aircraft so he immediately initiated the crash alarm. He then conducted the fire and accident checklist list procedures and made the necessary notifications.

1.17 Tests and Research

1.17.1 General.

The DFDR determined that the right landing gear down-lock indication occurred 6 sec before the left and the CVR confirmed a loud noise occurred at the same time. The rupture to the down-lock actuator also indicated that the right landing gear made an un-damped free fall extension possibly as a result of the hinge arm failure at the beginning of the gear extension sequence. The right landing gear hinge arm pieces found on the runway and the hinge arm piece still connected to the stirrup were delivered to the BE-A for initial inspection.

Preliminary investigation indicated that the failure had originated from two cracks (about 1-2 mm deep). In order to complete the examination, the BEA was authorized to send these items to the CEAT laboratories for further analysis.

1.17.2 History of Hinge Arm.

The manufacturer of the landing gear and hinge arm was Messier-Dowty, previously known as Messier-Hispano-Bugatti. The hinge arm part number, GA 57171-3, serial number 329 B, was delivered as a new component for the initial delivery of aircraft MSN 096. The documented history of the hinge arm was;

(a) Initial delivery on MSN 096 aircraft in March, 1980.

(b) In 1988, the main landing gear and hinge arm assembly were overhauled after 11967 landings

(c) On 31 March, 1991, the landing gear and hinge arm assembly were then installed on Airbus A300 B4, AP-BAZ.

(d) On 03 April, 2000, the main landing gear and hinge arm assembly were removed from AP-BAZ for overhaul after a further 13021 landings.

(e) During this overhaul the hinge arm was given an anti-corrosive temporary protective treatment in accordance with the manufacturer's Component Maintenance Manual (CMM) and placed in storage. The period between inspection and application of this temporary treatment could not be determined.

(f) On 03 August, 2000, the landing gear and hinge arm assembly were then installed on Airbus A300 B4, AP-BCJ again. At the time of the accident these components had added another 1665 landings since overhaul and a total of 26653 landings since new. The period between the removal of the temporary protective treatment and the application of the final protective coating could not be determined.

1.17.3 Laboratory Tests on Hinge Arm.

The tests indicated that the right hinge arm had failed at the level of the stirrup on which the main landing gear retraction actuator was attached. The laboratory metallurgical investigation of the broken parts provided the following information:

(a) The hinge arm rupture was the consequence of two main fatigue cracks in the lower part of the blending radii of the lateral trunnion. The cracks reached 2.75 mm and 1.3 mm depth prior to the final static rupture of the hinge arm.

(b) The size of crack calculated as being critical and capable of rupturing the hinge arm when under an operating load was determined to be 1.7 mm.

(c) These cracks initiated from two separate corrosion pits, located on the surface of the base metal, measuring 0.15 mm and 0.11 mm depth.

(d) In addition to these two main crack initiation points, several corrosion pits were noted in the same area of the rupture. Fatigue cracks had also developed from some of these corrosion pits.

(e) From measurement of the striations, it was estimated that the longer crack propagated during approximately 1900 landing gear cycles and the other crack during approximately 1700 cycles. Considering that a flight is two cycles (a take-off and landing), cracks propagated during a minimum of 950 and 850 flights respectively.

(f) Detailed examination of the parts indicates that the pits were covered with cadmium plating and paint. This last finding indicated that the pits were present prior to the re-protection (cadmium and paint) of the hinge arm during the last overhaul of the gear.

(g) The metal composition of the hinge arm was correct and conformed with the manufacturer's specifications. The metal hardness was normal.

1.17.4 Overhaul Inspection

1.17.4.1 Inspection Period

The manufacturer specified that the inspection of the hinge arm should occur every 12000 cycles or 8 years. The period between the last two inspections conducted by PIA was 13021 cycles and 9 years.

1.17.4.2 Manufacturer's Requirement. The Messier-Dowty CMM was reviewed in detail. CMM 32-14-15 page block 500 contained a specific inspection of the blending radii of the lateral trunnions. It stated that, after the component had been stripped of paint and the cadmium protective coating, a detailed visual inspection was to be carried out using a 9X magnifying glass. Advice from the hinge arm manufacturer and BE-A metallurgists indicated that the use of a 9X magnifying glass for the detailed visual inspection is adequate to sight the corrosion pits on this hinge arm. The inspection would be completed by a magnetic particle inspection in case of any doubt. This CMM inspection was appropriate for the identification of the type of defect found on the hinge arm. In the CMM, the manufacturer cautioned that the inspection was mandatory and that no defect was acceptable as the area was subjected to significant stresses. In particular:

(a) "This inspection is mandatory even if the hinge arm seems to be in a satisfactory condition."

(b) "No defect is acceptable"

1.17.4.3 Protective Treatment. The hinge arm manufacturer required either a permanent cadmium protective coating or a temporary protective coating be applied to this component to prevent corrosion. The CMM adequately described the method of application for permanent and temporary protective treatment during the overhaul. There was no guidance information found in respect to an acceptable period of time to leave the metal in an unprotected state. That unprotected state being the time between when the cadmium coating was removed during overhaul to the time of re-application of either a temporary or permanent protective coating. There was also no guidance on an acceptable length of time for the component to be stored with a temporary protective coating or the need for a subsequent inspection after storage.

1.17.4.4 Operator's Procedures. A detailed inspection of the operator's maintenance and overhaul records was conducted, and in particular the inspection of the lateral trunnions. The documentation indicated the work was carried out but was lacking information regarding the time interval between the removal and further application of the temporary and permanent protective coatings. There was no information available on the quality of the temporary protective treatment or the storage conditions. The PIA Airbus met the requirements of all applicable Airworthiness Directives and Service Bulletins.

1.17.5 Previous Incidents/Accidents Involving Airbus A300 B4.

A similar accident had occurred to a Garuda Indonesian Airlines Airbus A300 B4 on 28 April, 1988. In that accident the landing gear had collapsed after a hinge arm failure. The failure of the hinge arm was determined to be the result of a crack, which was initiated from burns caused during the stylus cadmium plating operation. The cause was related to the manual application of the cadmium protective coating and a French Direction Generale de l'Aviation Civile (DGAC) Airworthiness Directive No. 88-142-087 (B) was issued on 12 November, 1988 to revise the cadmium coating application.

1.17.6 Other Technical Tests.

As the door slides for L2, L4, R1, R2, R3 and R4 did not deploy, they were tested for correct operation. The L2 slide had caught in its webbing and was only partially inflated. The L4 door girt bar was found to have disconnected but the slide was capable of being inflated manually. There was no obvious reason for the non-deployment of the slides on the right side.

1.18 Organizational And Management Aspects

A review was conducted on the regulatory, operational and maintenance documentation provided by the operator. Apart from the delay in the inspection of the hinge arm, there were no irregularities found and all required information for the safe conduct of flights and the maintenance of Airbus A300 B4 aircraft was current and available.

1.19 Useful Or Effective Investigation Techniques

The use of the BE-A and CEAT laboratory facilities and metallurgic expertise was most effective in determining the corrosion and the development of the fatigue cracking.

2. ANALYSIS

2.1 Reconstruction of Events

2.1.1 General.

The following reconstruction of events was compiled from the data recorders and other factual information regarding the hinge arm component failure.

2.1.2 Approach.

When the landing gear was lowered, the DFDR and the resultant damage to the down-lock actuator indicated that the right main landing gear lowered at least 6 seconds before the left and was indicative of a lack of damping. This lack of damping was consistent with the hinge arm failure at the beginning of the gear extension sequence when the stresses on the hinge arm were high. Together with the accompanying loud bang heard on the CVR and by the crew, it is concluded that the right landing gear hinge arm failed just as the gear commenced its extension. This occurred at the location of the stirrup attachment. However, the hinge arm, although cracked, remained totally attached to the landing gear and did not separate until after landing.

2.1.3 Landing Roll.

After landing, the combination of vertical, lateral and longitudinal forces experienced during a normal and smooth touch down, was sufficient to cause the hinge arm to rupture completely. The laboratory analysis confirmed that the complete fracture occurred during two separate stages within a short period of time. After landing, parts of the hinge arm fell onto the runway. The right landing gear continued to support the weight of the aircraft almost until the time the nose wheel touched the runway. The marks on the runway clearly showed the right landing gear twisting inwards and backwards. The DFDR indicated that left rudder and nosewheel steering was used in an attempt to prevent the aircraft from leaving the side of the runway

2.2 Technical analysis

2.2.1 Hinge Arm Failure.

(a) The hinge arm conformed to the manufacturer's specifications and hardness. It failed due to fatigue, and specifically from two fatigue cracks in the lower part of the blending radii of the lateral trunnion. The cracks reached 2.75 mm and 1.3 mm depth respectively prior to the final static rupture of the hinge arm. The 2.75 mm crack exceeded the size of crack calculated as being critical and capable of rupturing the hinge arm when under an operating load (1.7 mm).

(b) These cracks initiated from two separate corrosion pits, located on the surface of the base metal, measuring 0.15 mm and 0.11 mm respectively. These corrosion pits were covered with cadmium plating and paint indicating that the pits were present prior to the re-protection (cadmium and paint) of the hinge arm during the last overhaul at the PIA engineering facility. The depth of the corrosion prior to the further application of cadmium would have been possible to detect by magnifying glass, which is the tool specified by the CMM.

2.2.2 Initiation of Corrosion.

There could only be five possible separate scenarios, or a combination of any scenario(s), which could account for the initiation of the corrosion pits before the permanent cadmium application. However, it could not be determined which of the following scenario(s) initiated the corrosion.

2.2.2.1 Initial inspection during overhaul. It is essential that trained and qualified engineers inspect the component in good light conditions using the recommended magnifying glass. The quality and training of the PIA engineering staff and the inspection techniques was not assessed. However, as the depth of these particular corrosion pits would have been possible to detect using the magnifying glass, it is most likely that the corrosion occurred after the initial inspection.

2.2.2.2 Long period of time before application of temporary protective treatment. The time interval between the removal and application of the protective coating was considered to be critical although the manufacturer's CMM wording does not stipulate a specific time frame. Whilst corrosion of unprotected metal, such as the hinge arm, is known to accelerate with exposure to the air, the rate of acceleration may be exacerbated by exposure to salt air, humidity and environmental pollutants as found at the PIA engineering base at Karachi, Pakistan. The actual length of time could not be determined.

2.2.2.3 Inadequate temporary protective treatment. If the temporary protective treatment had not been correctly applied to the hinge arm, corrosion could be initiated during the subsequent storage.

2.2.2.4 Condition of storage. The protection qualities of the temporary treatment of the hinge arm may have been reduced during the storage period of nearly four months. The conditions of storage and handling could not be determined.

2.2.2.5 Long period of time before application of permanent protective treatment. The time interval between the removal of the temporary treatment and the application of the cadmium protective coating was also considered a critical period, and once again there is no definitive guidance in this respect. The actual length of time could not be determined.

2.3 Human Factor Considerations

2.3.1 Engineering.

The period between the last two inspections conducted by PIA on this hinge arm exceeded the manufacturer's specifications. In addition, as the corrosion was initiated during the overhaul of the hinge arm, it raises the possibility of human factor inadequacies in the inspection, treatment or storage process. These matters were not subject to further investigation.

2.3.2 Evacuation.

Examination of evacuation process indicated that the evacuation slides on the right doors did not operate at all and only two of the slides on the left doors worked. The GCAA determined that there was an engineering defect on L4 door and incorrect packing on L2 door. At the time of the investigation of the right doors the day after the accident, there was no obvious reason for the non-deployment of the slides on the right side.

3. CONCLUSIONS

3.1 Findings

(a) The operator was correctly authorised by the Pakistan CAA to operate Airbus A300 B4 aircraft on scheduled international commercial operations.

(b) The aircraft was correctly registered, insured, and held a valid Certificate of Airworthiness.

(c) The aircraft was serviceable on departure from Peshawar with no known mechanical defects for the arrival at Dubai.

(d) The aircraft was within the centre of gravity limitations and carried sufficient flight fuel, plus reserves. The load-sheet was determined to be correct for the manifested passengers, freight and fuel.

(e) The crew were correctly licensed, rated, and met the recent experience and proficiency requirements for the Airbus A300.

(f) Each crewmember held a valid and appropriate medical certificate and neither suffered from a known medical condition or injury.

(g) The hinge arm of the right landing gear partially ruptured as the gear was lowered on final approach into Dubai.

(h) The right hinge arm completely ruptured after a smooth landing and allowed the right landing gear to collapse.

(i) The right hinge arm ruptured as a consequence of two main fatigue cracks in the lower part of the blending radii of the lateral trunnion. The cracks reached 2.75 mm and 1.3 mm depth respectively prior to the final static rupture of the hinge arm. These cracks initiated from two separate corrosion pits, located on the surface of the base metal, measuring 0.15 mm and 0.11 mm depth respectively.

(j) From measurement of the striations, it was estimated that the fatigue cracks occurred after at least 1900 and 1700 landing gear cycles respectively. This would equate to at least 950 and 850 flights.

(k) Detailed examination of the parts indicated that the pits were covered with cadmium plating and paint. This last finding indicated that the pits were present prior to the re-protection (cadmium and paint) of the hinge arm after the last overhaul.

(l) The metal composition of the hinge arm was correct and conformed with the manufacturer's specifications. The metal hardness was normal.

(m) The period between the last two inspections conducted by PIA on this hinge arm exceeded the manufacturer's specifications.

(n) The manufacturer's CMM wording does not stipulate the acceptable period of time between the stripping of the protective treatment and the application of another protective treatment on the hinge arm component.

(o) The aircraft left the runway onto an unprepared sandy area adjacent and almost perpendicular to the runway. The right wing fuel tank ruptured but did not ignite.

(p) The evacuation was delayed by the non-operation of six of the eight emergency evacuation slides.

(q) The reaction of the ATC and fire services was timely and appropriate.

3.2 Cause

The right landing gear collapsed as a consequence of hinge arm failure due to two main fatigue cracks initiated from two separate corrosion pits.

3.3 Contributory Cause

The corrosion pits, which led to the fatigue failure, occurred during the overhaul at the PIA engineering facility.

4. RECOMMENDATIONS

4.1 PIA is recommended to strictly adhere to the Airbus A300 B4 maintenance practices during the overhaul of components.

4.2 PIA is recommended to examine the human factor considerations regarding this accident and revise, formalise and document their procedures accordingly. In particular;

(a) The inspection period requirements for the hinge arm.

(b) the inspection, treatment and storage procedures during overhaul of hinge arm and other landing gear components.

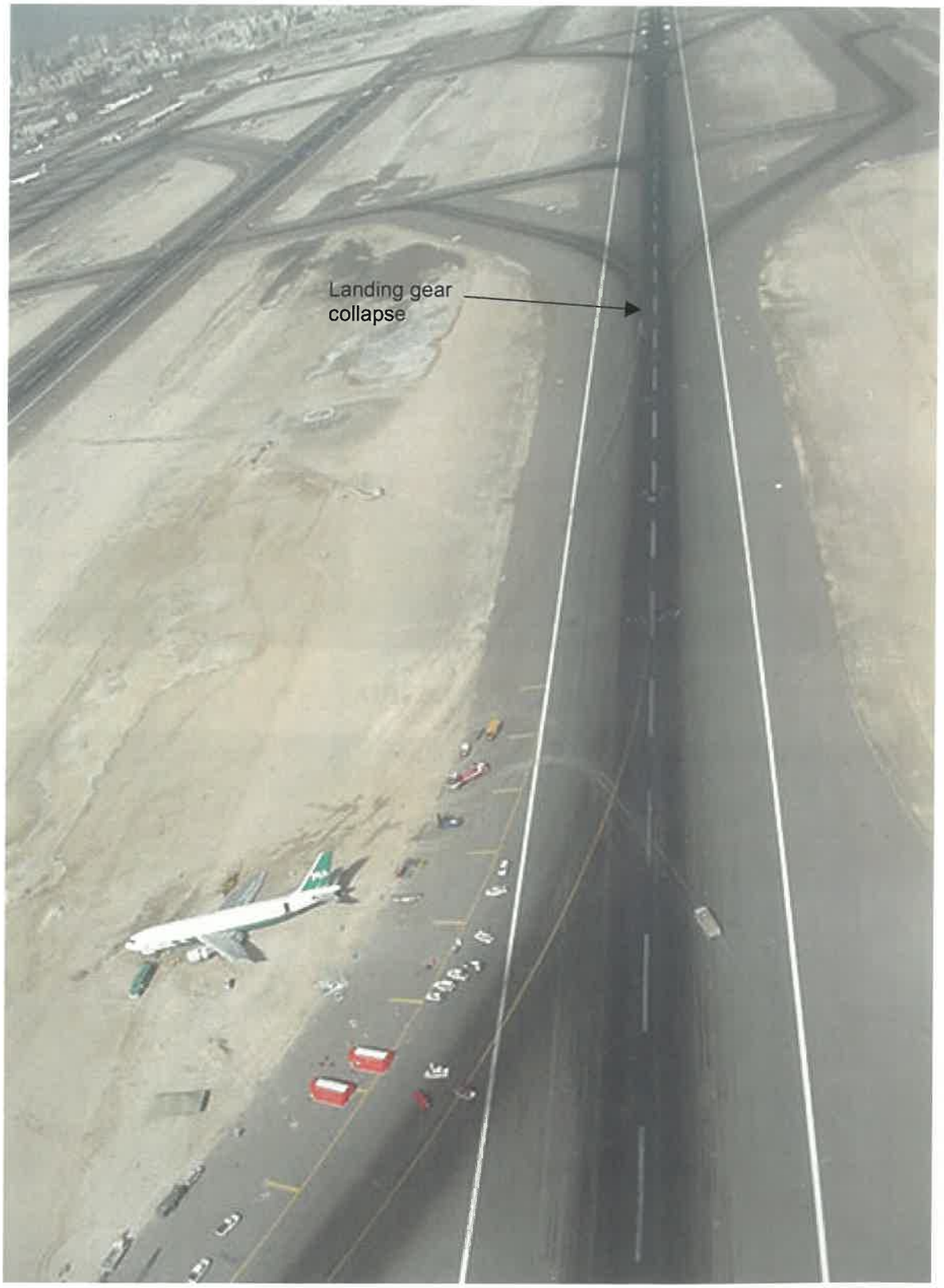
(c) the packing, operation and applicable training in respect to the emergency slides.

4.3 Airbus, in consultation with the landing gear manufacturer, is recommended to define the acceptable period of time between the stripping of the protective treatment and the application of another protective treatment on the hinge arm component.

4.4 Airbus, in consultation with the landing gear manufacturer, is recommended to ensure the CMM is amended to include the acceptable period of time in recommendation 4.3 above and to include adequate warnings regarding the protective treatments.

4.5 The Pakistan CAA is recommended to note the circumstances of this accident and recommendations 4.1 and 4.2 above.

4.6 The French DGAC is recommended to note the circumstances of this accident and recommendations 4.3 and 4.4 in consultation with the landing gear manufacturer above.



AERIAL VIEW

AIRCRAFT RHS

AIRCRAFT LHS

DEPARTURE OFF RUNWAY

LANDING GEAR AFTER COLLAPSE

HINGE ARM FAILURE (ATTACHED TO AIRCRAFT

HINGE ARM FAILURE (SEPARATED FROM AIRCRAFT)