

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

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AIRCRAFT INCIDENT REPORT ***7/97***

REPORT ON THE INCIDENT TO ***PAKISTAN INTERNATIONAL AIRLINE*** ***B747-200*** ***AT DUBAI INTERNATIONAL AIRPORT*** ***ON 28 DECEMBER, 1997***

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REPORT DATE: 01 May, 1998

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1. ABBREVIATIONS.

AAIB	U. K. Air Accident Investigation Branch
ASI	Air Speed Indicator
ATCO	Air Traffic Control Operations
CAA	Pakistan Civil Aviation Authority
CAR	Civil Aviation Regulations
CAS	Calibrated Airspeed
CVR	Cockpit Voice Recorder
DCA	Dubai Department of Civil Aviation
EGT	Exhaust Gas Turbine
EPR	Exhaust Pressure Ratio
FDR	Flight Data Recorder (Digital)
GCAA	General Civil Aviation Authority
GE	General Electric
HPA	Altimeter Setting
HPC	High Pressure Control
HTP	High Pressure Turbine
ILS	Instrument Landing System
Kgs	Kilograms
Kts	Knots
L1/R1	Left/Right Front First Exit Doors
L2/R2	Left/Right Second Exit Doors
L3/R3	Left/Right Third Exit Doors
L4/R4	Left/Right Fourth Exit Door

Lt	Local Time
m	Meters
Mhz	Megahertz
N1	Power turbine
NGV	Gas Generator Valve Assembly
PIA	Pakistan International Airlines
QNH	Altimeter Setting
SOP	Standard Operating Procedures
UAE	United Arab Emirates
UTC	Coordinated Universal Time
V ₁	Decision Speed
V _r	Rotation Speed
VHF	Radio Frequency

2. SYNOPSIS.

2.1 General

Registered Owner	M/S Pakistan International Airlines Corporation
Registered Operator	Pakistan International Airlines
Aircraft type & model	Boeing B747-200
Nationality	Pakistani
Registration	AP-BAT
Flight Number	PK-787
Place of Accident	Dubai International Airport United Arab Emirates Latitude: N25 15.1 Longitude: E 055 21.7
Date & Time	28 December, 1997 12:54 lt - 08:54 UTC

2.2 Investigation

2.2.1 This serious incident occurred while the aircraft was on a departure from Dubai International Airport.

2.2.2 The UAE GCAA was notified of this incident at 13:30 local time on the 28 December 1997. Under authority of the Director General, GCAA investigation of the occurrence was immediately undertaken.

2.2.3 The following, personnel were nominated to the Aircraft Accident Investigation Committee by UAE Decree:

Mr. Mohamed Ghanim Al Ghaith Director General, GCAA	-	Chairman.
Capt. Don G. McArthur GCAA Flight Operations Inspector	-	Chief Investigator.
Mr. Jamal Hussain Safety Board, CAA Karachi	-	Investigator, Operations.
Mr. Niaz Jawaid PIA Sr. Aircraft Engineer	-	Official Observer, Airworthiness.
Mr. S.P. Marya GCAA	-	Investigator, Airworthiness.
Mr. P. A. Fernando GCAA	-	Investigator, Airworthiness.
Mr. Graham Jones GCAA	-	Official Observer, ATC Services.
Mr. Alan Roberts DCA Mgr. Technical Services	-	Official Observer, ATC Services.
Mr. Alan Skennerton DCA Mgr. Safety/Security	-	Official Observer, Airport Safety.
Capt. Bakhtyar Ahmad Chaudhri PIA Chief Pilot, Corporate Safety	-	Observer Operations.

2.3 Flight Overview

The registered owner of Pakistan International Airlines is, M/S Pakistan International Airlines Corporation. PIA's main base of operation is located at Karachi, Islamic Republic of Pakistan. On this particular flight, PIA 787 was attempting to take off on Runway 12 at Dubai International Airport on a scheduled flight to London, UK.

During the take-off PIA 787 experienced a failure of the No.2 engine. The Captain aborted take-off at high speed. He was unable to stop the aircraft and proceeded off the runway end into the ILS localizer fence. The aircraft was evacuated, no injuries were reported.

3. FACTUAL INFORMATION.

3.1 History of the flight

At 08:54 UTC, PIA 787 commenced takeoff for London UK with 2 pilots, 1 flight engineer, 12 cabin attendants and 246 passengers. PIA 787 carried 44,148 kgs of cargo and 88,000 kgs of fuel for a total take-off weight of 346,540 kgs. The aircraft was 16,333 kgs under the maximum permissible take-off weight.

On receipt of ATC clearance, the Captain taxied to the designated holding point Kilo, for a Runway 12 departure. Pre-takeoff checks were completed as required by company SOP's. For this take-off, using a flap 10 setting, the crew calculated a V_1 of 155 kts, V_r of 167 kts and V_2 at 178 kts using a reported temperature of 24 deg celcius. The wind was calm, and altimeter setting given as 1019.0 hpa. A take-off power of 112.6 % N1 was used.

PIA 787 was cleared onto Runway 12 for the take-off. The Captain advanced engine power and the co-pilot monitored the flight instruments as the aircraft accelerated. The aircraft tracked normally along the runway centerline. At 155 kts indicated airspeed, the co-pilot called V_1 .

Just prior to, and within 2 to 3 seconds following V_1 , three loud bangs were heard, (engine compressor stalls). The Flight engineer noticed the No.2 EGT indication rising rapidly beyond the allowable limit and advised the Captain to take reject action. At approximately 162 kts the Captain applied manual braking, deployed the speed brakes and retarded the power levers to idle. The aircraft continued to accelerate to 167 kts, remained at that speed for approximately 4 seconds then commenced deceleration. The Captain reported that the aircraft vibrated significantly as a result of the No.2 engine failure and that the cockpit environment became exceptionally noisy, making it difficult to hear the calls made by the First Officer and Flight Engineer.

During the rejected takeoff, the aircraft tracked along the runway centerline until approaching the end, then realizing that he was facing an overrun, the Captain turned the aircraft slightly left in an attempt to avoid ground obstacles. The aircraft ran over two runway lights, then into the ILS fence and proceeded off the runway end.

Due to extreme high tire temperatures all main wheel tires auto-deflated by means of pressure relief safety valves. After arriving at a full stop, the No.1 engine intake nacelle was located within approximately 3m of a small shed that contained associated ILS equipment.

The flight crew confirmed that there was no flight deck instrument indication of an engine fire and completed a normal engine shutdown. The APU was used to provide electrical power and maintain a suitable climatic environment. A senior DCA Operations Supervisor and Ground Marshaller, witnessed the PIA B747 overrun. They were the first to arrive at the aircraft and attempted to signal the Captain of both main wheel assemblies expelling smoke and fire. The Operations Supervisor called ground Operations on UHF and advised of the situation. The Fire Chief then arrived followed by fire truck's No.1 and No.2. Fire truck No.1 proceeded around to the aircraft's left front side and immediately commenced with spraying of foam on all main wheels to contain the fire. Water was then applied to cool the main wheels.

The Fire Chief attempted to signal the Captain to shut down the APU power and evacuate the aircraft but the signals were not understood. The Captain advised ATC that he required the stairs for off-loading of all passengers to prevent possible injuries. All doors and exits remained closed. The Fire Chief, through ATC, requested that PIA 787 shut down the APU and evacuate the aircraft.

A senior purser seated in the jump seat next to the L1 exit attempted several times to contact the Captain on intercom, but failed to do so. She had been informed by the flight purser stationed at L2, of smoke outside the aircraft. The senior purser then ran upstairs to advise of the smoke and to obtain instructions. Upon arriving at the cockpit the purser glanced outside and witnessed the fire crews using their fire equipment. The Captain initially asked the purser to standby, then having been informed of the Fire Chief's urgent request by ATC, commanded an immediate evacuation out the right side of the aircraft.

AT 08:57, ACT acting on the "aborting" call from PIA 787, activated the emergency crash alarm. The alarm sounded directly in the Watchtower control room and the lower fire hall station. ATC reported difficulty in reaching the Watchtower by land phone at time of the sounding of the crash alarm. This resulted in a short delay in the Watchtower being advised of the emergency situation which in turn, created a short delay in advisory to the five fire rescue vehicles with exception of the two vehicles that immediately followed the Fire Chief to the overrun site. ATCO also experienced difficulty in contacting appropriate authorities on the DCA emergency notification callout list. The Director General, GCAA when notified of the PIA 787 overrun at Dubai Airport, quickly responded by directing GCAA operations to commence with investigation of the incident.

The CVR, FDR and related aircraft documents were secured for evidence by GCAA. Police photographs including a video taken of the aircraft following the overrun incident were made available to GCAA. ATCO provided transcripts of the conversations between PIA 787, the Watchtower and the Fire Chief. Statements from witnesses were obtained and form part of the appendix to this report.

3.2 Injuries to persons

There were no injuries reported.

3.3 Damage to Aircraft

The aircraft overran the runway end at relatively slow speed. There was no reported damage to the fuselage or undercarriage with exception of the engines.

3.4 Other Damage

Two runway edge lights were damaged. The ILS Localizer electronic transmitter and fence lighting were damaged.

3.5 Personnel Information

3.5.1	Captain	:	Pakistani National
		:	Birth Date -12/09/47
		:	Valid Pakistani ATPL
	Medical Certificate	:	Class 1 Valid on 21/7/97
	Aircraft Types	:	B707, B737, A300, DC10, B747
3.5.2	Co-Pilot	:	Pakistani National
		:	Birth Date -13/12/49
		:	Valid Pakistani ATPL
	Medical Certificate	:	Class 1 Valid on 24/09/97
	Aircraft Types	:	C150/152, F27, DHC6, B737, A300, B747
3.5.3	Flight Engineer	:	Pakistani National
		:	Birth Date - 14/01/43
		:	Valid Pakistani Licence
	Medical Certificate	:	Valid on 25/10/97

3.6 Aircraft Information

Type/Model	:	B747-200
Serial No.	:	22077
Certification of Registration	:	Transport Category CERT. No 543, Dated -18/12/1984
Certificate of Airworthiness	:	AP-BAT (Pakistan) CERT. No 496 Valid - 07/03/97 to 06/03/98
Engines	:	CF6 - 50E2
Centre of gravity	:	CG - MAC 29.2% AEW Index 66.7
Take-off weight	:	362,873 kg
Landing weight	:	265,351 kg

3.7 Meteorological Information

3.7.1 General.

The weather was not considered to be a contributing factor to this incident.

Wind	:	calm
Visibility	:	clear
Cloud	:	nil
Temperature	:	24 Celcius
QNH	:	1019.0
Runway Surface	:	Asphalt, bare and dry.

3.8 Communications

Dubai Tower was communicating on 124.0 Mhz and all transmissions at time of the incident were recorded. Other aircraft and various airport vehicles were on frequency during the incident. The Fire Chief, in his vehicle and monitoring tower frequency, heard the aborted take-off call by PIA 787. All fire rescue vehicles were initially on standby in the lower Watchtower station. Two of the fire rescue vehicles immediately followed the Fire Chief and the three remaining vehicles were dispatched shortly following sounding of the emergency alarm.

3.9 Aerodrome Services Information

3.9.1 Air Traffic Control.

Dubai Airport is a UAE International Aerodrome. Runway 12 dimensions are 4000m by 46m with full facilities. At time of the incident, licenced personnel were on duty in the ATCO control tower. An ATC trainee, under supervision, was also in the control tower. ATCO witnessed the PIA 787 on takeoff at the time of the "abort" call and immediately responded by twice sounding the crash alarm. The alarm was simultaneously received in the Watchtower and fire hall. ATCO attempted to contact the Watchtower by landline, but experienced difficulty in doing so.

3.9.2 Airport Fire Services.

The Operations Watchtower is manned continuously by two qualified watchmen. Either ATCO or the Watchtower is capable of sounding a crash alarm. The alarm sounds simultaneously in the Watchtower, at other remote sites located on the aerodrome and in the Watchtower lower fire hall station. The fire station doors open automatically with the crash alarm signal, but can also be remotely operated from within the watchtower and/or from within the fire hall station.

3.9.3 Civil Defence.

Fire rescue personnel, airport police and airport officials were very quickly on location at the overrun site. All promptly assisted with the overrun incident. An ambulance was called in to the site to take a fainting wheel chair evacuee to the hospital for medical surveillance.

3.10 Flight Recorders

3.10.1 The CVR and FDR recorders recovered from PIA 787 were taken by GCAA operations to the Air Accidents Investigation Branch at DERA Farnborough Hants United Kingdom, for formal analysis. The CAA Karachi, Pakistan and Chief Pilot Corporate Safety PIA Karachi Pakistan, were in attendance during formal review of the flight recorders.

3.10.2 Cockpit Voice recorder.

Type	Allied Signal
Model	AV557C P/No. 980-6005-076
Serial No.	9224

3.10.2.1 The CVR recordings were audible. The compressor stalls, V₁ call and the “cut” calls were identifiable. The CVR displayed a constant loud cockpit background noise. The UK AAIB was able to filter out most of the background noise during review of the cockpit conversations by the GCAA team members.

3.10.3 Flight Data Recorder.

Type	Allied Signal
Part No.	P/No. 981-6009-014
Serial No.	2388

3.10.3.1 The UK AAIB initially experienced difficulty in reading of some parameters of the FDR. Arrangement was made for the FDR to be forwarded to Allied Signal for servicing. The FDR on return to AAIB was reported to be capable of approximately an 80% total data output. The data required by the GCAA investigating team members specifically covering the takeoff through to a complete shutdown of the aircraft was accurately recorded. The FDR parameters clearly indicated a loss of thrust on the No.2 engine at 163 kts, 08 kts above V₁ speed. The parameters also show that reverse thrust was not selected until approximately 50 kts.

3.11 Medical Information

All passengers and crewmembers exited the aircraft safely. One passenger fainted during the evacuation and was subsequently taken to the hospital for a medical analysis, was later discharged, and traveled onward to Heathrow.

3.12 Fire

British Airways Flight No. 136 next in sequence for the takeoff witnessed and reported seeing a fire in PIA's No.2 engine at the time of the rejected takeoff. The Fire Chief and two airport ground crew personnel reported smoke and fire at the main wheel assemblies and provided GCAA with written statements. PIA technicians stated that upon their later inspection of the main wheel assemblies there was no visible indication of any source of fire.

3.13 Survivability Aspects

Eleven minutes had elapsed before the evacuation had completed and all persons were off the aircraft. All passengers and flight crewmembers evacuated without injury.

3.14 Cabin Crew Aspects

3.14.1 Cabin Attendant Overview.

This overview is prepared from written statements received from all 12 Cabin Attendants assigned as crewmembers to PIA 787 during the overrun incident.

(a). From passenger boarding to takeoff positioning;

A normal routine boarding with transit passengers seated prior to the addition of joining passengers. A wheelchair passenger was helped aboard and seated on the upper Club Deck. Door arming was requested and acknowledged. The cargo area latch retainer was locked and the aircraft pushback acknowledged. Taxi commenced and announcement was made for all cabin crewmembers to assume their takeoff positions. No unusual sounds or motions were noted or detected.

(b). Start of takeoff roll to reject;

The takeoff roll commenced at 08:41 UTC and continued normally up to the V_1 speed. One passenger reported that he had felt the sensation of aircraft rotation. All attendants reported hearing a loud bang and some stated they felt an unusual movement of the aircraft. All attendants stated that they felt the engine power being pulled back and one passenger stated that he felt the sensation of a nose wheel re-contact with the runway surface.

(c). From rejected takeoff to stopping of aircraft;

All attendants reported that they felt the brakes being applied and had witnessed dust and smoke on the left outside, as the Captain attempted to stop the aircraft. The cabin attendant seated at R2 witnessed smoke coming from an area adjacent to the No. 2 engine.

(d). Stoppage of aircraft to evacuation;

An attendant reported seeing the fire crew spraying water under the aircraft. There was a slight panic on the aircraft and some attendants reported attempting to maintain control and calm the passengers. The attendants reported that following stoppage of the aircraft, the Captain ordered evacuation out the right side exits.

(e). Evacuation;

Door R1 opened correctly but the escape slide did not inflate and fell to the ground. The R2 door was difficult to open and required the assistance of a second flight attendant. The attendants could hear the puncture of a pneumatic bottle as the door opened. The escape slide did not inflate or extend and remained non-deployed in its pack. Doors R3, R4 and their associated escape slides operated correctly. These exits were used by a majority of the evacuating passengers. The cabin attendants shouted to their passengers to unfasten seatbelts, remove shoes, leave hand baggage and proceed towards R3 and R4 exits.

The wheelchair passenger was assisted by cabin crew from the Club Deck down to the R3 exit and then by the fire crew down the exit slide. The Fire Chief placed a ladder at the R2 exit and which was used by some of the passengers during the evacuation.

All areas onboard the aircraft were checked for possibility of remaining passengers by the cabin attendants and the fire crew. The Captain then ordered all cabin attendants to evacuate the aircraft. A few attendants left via R3 and R4 exit slides, however most waited and then used the stairs placed at the R1 and R2 exits. The cabin attendants reported that a normal passenger evacuation was completed within approximately 2 minutes. The Captain, flight crew and a few remaining cabin attendants were the last to exit the aircraft.

3.15.2 Emergency Services.

Fire Rescue was quickly on location and secured the aircraft. One ambulance was required to escort a fainting wheelchair evacuee passenger to the hospital for surveillance. ATCO remained in control of airport traffic and temporarily closed the airport.

4. ANALYSIS.

4.1 Brakes

Manual braking, anti-skid, airbrakes and symmetric reverse-thrust, were used during the rejected takeoff in an attempt to stop the aircraft. Manual braking was applied after V_1 and continued until the aircraft came to a full stop. Auto-braking was available only for landing and not available for the takeoff. Due to the use of maximum braking, all main wheel brake assemblies suffered heavy frictional wear, causing an extreme high temperature buildup. This resulted in the main wheel assemblies expelling smoke and fire. Fire rescue personnel sprayed foam on the main wheel assemblies to contain the fire and then used water to lower the temperature.

4.2 Statements

4.2.1 Captain.

The Captain was the pilot flying and executed the takeoff. The takeoff was reported as normal until a few faint explosions were heard just prior to V_1 . After V_1 a series of louder explosions occurred and the Flight Engineer called, "cut." Then a very loud explosion occurred and again the Flight Engineer called out "cut," "cut." The Captain responded and at approximately 162 kts elected to stop the takeoff. At approximately 50 kts, following the Flight Engineers "outboards" call, full reverse was selected on engines No.1 and No.4. Approaching the runway end, the Captain steered the aircraft slightly left of centerline to avoid ground obstacles.

4.2.2 Co-pilot.

The co-pilot verified the Captains testimony and reported that he had called V₁ at 155 kts indicated airspeed.

4.2.3 Flight Engineer.

The Flight Engineer verified the Captains statement and the V₁ call made by the First Officer at 155 kts. He testified that he had heard the explosions prior to and following V₁. He stated that he had witnessed the No.2 EGT gauge climbing rapidly through allowable limits, had made the "cut" calls and called "outboards," for a full reverse thrust selection on No.1 and No.2 engines by the Captain.

4.3 Landing Gear

The forward nose-wheel landing gear and main landing-wheel gear were not damaged. All main wheel tires auto-deflated, due to the extreme high temperature and internal high-pressure buildup.

4.4 Fuselage

No reported damage.

4.5 Cockpit

No reported damage.

4.6 Cabin

There was no damage or injuries reported within the cabin area as a result of the rejected takeoff.

4.7 Wings

No reported damage.

4.8 PIA Inspection

4.8.1 No.2 engine.

4.8.1.1 A reported engine stall associated with an internal seal and a high-pressure turbine failure resulted in the EGT exceeding operational limits. Gravel was found in the engine intake inlet. Metal was found in the exhaust outlet.

4.8.1.2 Findings indicated that a 0.100 inch wide open 180 degree circumferential crack on No.4 bearing pressure balance seal forward outer skin caused displacement of the seal in a reward direction. The HPT stage one NGV assembly being mounted on the seal came in contact with the HPT stage one blades and chopped them off at high rotational speed. Detached pieces of the blades caused further secondary damage to downstream hardware. After installation on PIA 787, (AP-BAT) the engine installed at No.2 position, failed following 145 hours/35 cycles. Engine disassembly was conducted by PIA in presence of a local General Electric representative who stated that the seal would undergo further analysis by GE. Following disassembly in Karachi, CAA officials witnessed the failed hardware.

4.8.1.3 Engine building records indicated that the engine had been fully overhauled by Aviall. No.4 bearing pressure balance seal had been installed after accomplishment of the applicable Service Bulletins. Gravel in the engine inlet was due to overrunning of the runway, which did not cause damage to the booster or HP compressor. HPC airfoils were found dirty and eroded but remained free of damage.

4.8.2 No.3 engine.

4.8.2.1 Engine intake nose nacelle casing, the interior casing and fan blades were damaged. The foreign intake damage occurred as the aircraft left the runway and penetrated the localizer fence.

4.9 Emergency exits/escape slides

4.9.1 R1 door/escape slide.

The slide assembly mounted at R1 failed to deploy. Investigation by PIA revealed that emergency slide P. No. 7A1238-10, S/No. G1146 mounted at door R1 failed to deploy due to the firing line not connected to the inflatable unit. PIA has defined this as a serious shop discrepancy and reported having taken appropriate action to prevent recurrence. The R1 door was removed and released for service by PIA.

4.9.2 R2 door/escape slide.

This door was found to be exceptionally difficult to open and required the assistance of a second attendant. Investigation by PIA revealed that non-deployment of slide P. No. 7A1238-58, S/No. G444 was questionable, as all indications of normal deployment were evident. The slide reservoir discharged and the mechanical restraints were properly disengaged. The slide is now slated to undergo a further PIA analysis regarding serviceability. R2 door was removed and sent for service.

4.10 **Analysis Summary**

From the CVR, FDR and crew statements it is clear that the No.2 engine thrust failed after V1. Contrary to PIA SOP's, the Captain elected to reject the takeoff after V1. Considering the weather, runway conditions, aircraft takeoff weight and the loss of No.2 engine, had the Captain continued with the takeoff, he could have avoided running off the end of the runway and safely executed a return landing.

5. CONCLUSIONS.

5.1 Findings

- (a) The aircraft was properly maintained, correctly loaded, under the legal maximum certified allowable takeoff weight and held a valid Certificate of Airworthiness.
- (b) All aircraft systems were operating normally prior to takeoff.
- (c) The operating flight crew were properly licenced and adequately experienced to conduct the flight.
- (d) The weather was reported clear, the wind calm and the asphalt runway bare and dry.
- (e) No.2 engine failed and thrust was lost at 8 kts above V₁. The Captain elected to reject the takeoff.
- (f) The Flight Engineer called “cut” three times following V₁, contrary to PIA SOP’s.
- (g) On arrival at the aircraft, the Fire Rescue crew used foam and water to contain and cool the main wheel well assemblies.
- (h) There was a short delay in communications between ATCO and the Watchtower following sounding of the crash alarm. This further complicated the Watchtower’s ability to advise and direct the rescue vehicles immediately to the overrun site.
- (i) The Fire Chief, from the ground, was unable to communicate directly with the Captain or flight crew.
- (j) Evacuation was delayed while the Captain waited for arrival of the two sets of stairs for unloading of the passengers.
- (k) R1 and R2 exits/slides were discovered unserviceable for the required emergency evacuation.
- (l) After a delayed order by the Captain most of the passengers and some cabin attendants evacuated out the aircraft R3 and R4 exits using the emergency slides.
- (m) With exception of the landline, there is lack of a positive system in the ATCO control tower, to confirm that the alarm positively sounded in the Watchtower.
- (n) ATCO experienced difficulty in activating the emergency advisory callout list.

5.2 Cause

The Captain made the decision to reject the takeoff after V₁ contrary to PIA SOP's.

5.3 Contributory Cause

The Flight Engineer called “ cut” three times after the aircraft had reached a V₁ decision speed and in all probability, influenced the Captains decision to discontinue with the takeoff.

6. SAFETY RECOMMENDATIONS.

The following safety recommendations are offered:

- (a) PIA to ensure that Standard Operating Procedures are complied with.
- (b) PIA to review and consider current aircraft evacuation procedures.
- (c) PIA to review and confirm that current Maintenance Policies and procedural checks are adequately performed to positively ensure the serviceability of emergency exits and slides/rafts.
- (d) ATCO and Airport Rescue Operations ensure that a workable acceptable standard of emergency communication is established and practiced.
- (e) DCA consider implementation of a system to enable communication by the fire rescue personnel with a Captain or other members of the flight crew in event of an aircraft/aerodrome emergency.

7. APPENDICES.

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D.















