

ORIGINAL

NO.HQCAA/1901/223/SIB



CIVIL AVIATION AUTHORITY

**AIRCRAFT ACCIDENT INVESTIGATION M/S PIAC
BOEING - 737 REG.NO.AP-BCE WHICH OCCURRED
ON 21ST OCTOBER, 1997**

AT

**QUAID-E-AZAM INTERNATIONAL AIRPORT
KARACHI.**

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CIVIL AVIATION AUTHORITY
KARACHI, PAKISTAN

INVESTIGATION IN RESPECT OF ACCIDENT TO M/S PIAC
AIRCRAFT BOEING 737 REG NO. AP-BCE OCCURRED ON 21ST
OCTOBER, 1997 AT QIAP KARACHI.

Authority:- Director General Civil Aviation Authority
Memorandum No. HQ CAA/1901/223/SIB dated
21st October, 1997 (Appendix 'A')

Composition Of Investigation Team

- | | | |
|-----|--|-----------------------|
| (a) | Air Commodore(Retd)
Rashid A. Bhatti
Pilot Investigator, SIB | Investigator Incharge |
| (b) | Wg Cdr (Rtd) Sajjad Ahmed
Technical Investigator, SIB CAA | Investigator |

1. AIRCRAFT INFORMATION

- | | | |
|------|--|--|
| 1.1. | Aircraft type | : Boeing-737 |
| 1.2. | Reg. NO. | : AP-BCE |
| 1.3. | Engine types, airframe
positions & S.Nos. | : CFM56-3B: NO.1-720-205
NO.2 - 520-220 At time of the
incident. |
| 1.4 | Certificate of Registration | : S.No. 580/29.06.1985 |
| 1.5 | Certificate of
Airworthiness No. & date
of expiry, and flight
manual No. | : Upto 28.06.1998
CAA-462 (Rev-II) |
| 1.6 | Certificate of Safety date
& time (GMT) of issue and
period of validity. | : SIG. on 28.09.1997/TSN
28711-26.
Expire on 29511-26. |
| 1.7 | Date of construction of
airframe. | : 25.06.1983 |
| 1.8 | Name address of Owner. | : P.I.A.C. QIAP Karachi. |

- 1.9 Airframe history. (Give : (TSN-2886-08, LDG-28152)
flying times since Check-D C/out on 15.01.1995.
manufacture, last TSN-21972-42 Hours.
overhaul and last periodic
check. List also essential
modifications completed.
- 1.10 Engine history. (Give : No.1. 720-205, No.2 720-220
flying time since TSN: 21303-42, 20460-26
manufacture, last (At the time of the incident)
overhaul and last periodic
check. List also essential
modifications completed).
- 1.11 Gross Weights. Maximum : 31648.3 KGs (A/C as
permitted by C of A for Weighted) 29095.83 (Empty
this flight, at the time of Weight)
accident.

2. CREW INFORMATION

2.1 **Pilot-in-Command**

- 2.1.1. Name : CAPTAIN Qamar Habib
- 2.1.2. Position in the Cockpit : CAPTAIN
- 2.1.3. Date of Birth : 30.04.1955
- 2.1.4. Type of Lic and No : ATPL NO. 667
- 2.1.5. Medical date with : 14.10.1997 Class-1.
status

2.1.6. **Rating**

- 2.1.6.1. Type(s) held : B-707, B-737, F-27, A-300, B-747
:
- 2.1.6.2. Type current : B-737

2.1.7. **Flying Experience**

- 2.1.7.1. Grand total : 10094
- 2.1.7.2. Total -in - : 1756
Command

2.1.7.3. Total -in - : 678
Command
on the type
accident/
incident
occurred

2.2 Co-Pilot

2.2.1. Name : F/O Muhammad Issa

2.2.2. Position in the Cockpit : First Officer

2.2.3. Date of Birth : 15.01.1962

2.2.4. Type of Lic and No : CPL NO. 1668

2.2.5. Medical date with : 02.07.1997 Class-1.
status

2.2.6. Rating

2.2.6.1. Type(s) held : B-737, F-27

2.2.6.2. Type current : B-737

2.2.7. Flying Experience

2.2.7.1. Grand total : 2620

2.2.7.2. Total -in - : -
Command

2.2.7.3. Total -in - : 88
Command
on the type
accident/
incident
occurred

3. SUMMARY OF ACCIDENT

3.1. Captain Syed Qamar Habib ALTP No.667 and First Officer Muhammad Isa CPL No.1668 of PIA were scheduled to operate PK-342/343 on 21st October, 1997 from Karachi - Faisalabad - Karachi on Boeing-737 aircraft Reg.No.AP-BCE. Prior to departure from Karachi the aircraft No.1 thrust reverser was inoperative and aircraft was operated under MEL Coverage. PK-342 was operated without any incident. PK-343 departure from Faisalabad was normal and did not observe any abnormality during climb, cruise and descent. During cruise Captain came to know that it was raining at

Karachi and Runway 07L was in use. At final approach when flaps were selected from 25 degree to 30 degree position they failed to go to 30 degree. During approach the aircraft experienced turbulence and rain shower. The braking action reported by different types of landing aircraft i.e. A-300 and BAC-III, was from Medium to Poor. While maintaining approach speed of 150 Kts due to flaps and wind additive (Bug Speed 135 Kts) the aircraft landed at about 2351 hrs PST using the runway 07L. However, close to middle of the runway the Captain felt that the aircraft deceleration was not adequate and he opted to go for manual braking. Approximately 2000 feet short of runway end the aircraft was still at high speed and thereafter the aircraft started skidding and went into the over run (stop way) area and came to a stop about 650 feet passed the runway end and to the right edge of stopway on the heading of 210 degree in kutcha area.

- 3.2. All 95 passengers and 8 crew members on board the aircraft were safe and disembarked the aircraft through L1 door using the steps. DATCO immediately despatched the "Fire Vehicle" to the scene of accident and took actions as per SOP. After the accident the runway remained close for about 15 - 20 minutes and subsequently take off from runway 25R and landing from 07L was allowed by Director QIAP. The damaged aircraft was lifted with the help of "Air Bags" and towed to the maintenance hanger at 1330 hrs on 22.10.1997.

4. INJURY TO PERSONS

- 4.1. There was no injury to any passenger or the crew members.

5. DAMAGE TO AIRCRAFT

- 5.1. B-737 aircraft Reg.No.AP-BCE sustained substantial damage as a result of this accident. (See Appendix 'B' and 'C' for photographs of the aircraft and details of damage to aircraft respectively).

6. OTHER DAMAGES

- 6.1. None

7. METEOROLOGICAL CONDITION

- 7.1. The actual weather at the time of landing i.e. at 2351 hrs PST on 21.10.1997 at Karachi airport was raining and

presence of thunder storm in the area, surface wind 360 / 15 - 20 knots visibility was 3 to 4 miles (See Appendix 'D').

8. **AIDS TO NAVIGATION**

8.1. NDB was serviceable at the time of accident I.L.S. is available for landing at Runway 27R at Karachi Airport. However, I.L.S. is not installed for landing at Runway 07L.

9. **COMMUNICATION**

9.1 Normal communications were maintained between the aircraft and ATC through out the landing approach. The copy of the Tape Extract of Approach Radar and DATCO is placed at Appendix 'E'.

10. **AERODROME AND GROUND FACILITIES**

10.1. Karachi Airport has two runways i.e. 07L/25R and 07R/25L. The runway 07L was the runway in use at the time of accident. This runway is 10500 feet in length and 150 feet wide with over-run of 1000 feet on each end. At the time of landing the runway was wet due to rain.

11. **FLIGHT RECORDERS**

11.1. At the time of accident B-737 aircraft Reg.No.AP-BCE was fitted with a Flight Data Recorder and Cockpit Voice Recorder. Both the recorders were recovered from the aircraft. The DFDR serial No.3033 was taken to PIAC laboratory for its read out. The DFDR Read out and other calculations made to determine the touch down point, speed and other relevant details are placed at Appendix 'F'.

12. **WRECKAGE**

12.1. The aircraft after over shooting the runway 07L during landing came to a final resting position on the right edge of the stop way about 650 from the end of the runway 07L. The sketch of accident site of B-737 aircraft AP-BCE is placed at Appendix 'G'.

13. **FIRE**

13.1. No fire occurred during or after the accident.

14. SURVIVAL ASPECTS

- 14.1. All passengers and crew members were safe and no person was injured as a result of this accident.

15. TEST & RESEARCH

- 15.1 Nil.

16. OBSERVATIONS

- 16.1. There appears to be a general practice in PIAC that, if a reported defect is covered under MEL, no positive effort is made to rectify the fault even where the base maintenance facility exists. This is being done to meet the next flight schedule by releasing the aircraft on MEL.
- 16.2. MEL No.78-01 on Thrust Reverser System of B-737 aircraft is being interpreted differently by different people as the language used in the Note-1 and Note-2 of the said MEL and its implications are not clearly understood by the Operational and Maintenance Staff (See Appendix 'H').
- 16.3. The MEL is silent on the procedure to be followed for the release of aircraft without carrying out the rectification on the defect covered under MEL when the Captain has "Star Marked" the defect.

17. WITNESSES

- 17.1. Statement of witnesses are given in Appendix 'J1' to 'J10'.

18. INVESTIGATION

- 18.1. On 21st October, 1997 M/s PIAC Boeing -737 aircraft Reg.No.AP-BCE while operating PK-343 from Faisalabad to Karachi had an accident during landing at Karachi Airport. The aircraft overshot the runway 07L and came to a final stop on the right edge of the stopway about 650 feet from the end of runway 07L on heading of 210 degree in the Kutcha area. The actual weather reported at the time of landing at Karachi Airport was thunder storm and rain, surface wind 360/ 15-20 kts and runway condition was wet. The braking action reported by different types of aircraft landed just prior to the accident aircraft (B-737) was :Medium to Poor". The Captain stated that when flaps were selected to 30 degree position they remain stuck at 25 degree position. Therefore

keeping in view the presence of turbulence on final approach, flaps stuck at 25 degree and gusty wind conditions a final approach speed of 150 knots was maintained instead of previously calculated Bug speed of 135 kts (See Appendix 'K').

- 18.2. The Captain stated that the aircraft touch down approximately 1500 to 2000 feet down the runway 07L. Immediately after touch down captain confirmed auto deployment of ground spoilers, selected the available reverse thrust (No.2 Engine). However, halfway down the runway he felt that the aircraft deceleration was not adequate, therefore, he opted to go for manual braking. About 2000 feet short of runway end the aircraft was still at about 60 knots and now aircraft started skidding viciously and went into the stopway area.
- 18.3. MEL Release. On 20th October, 1997 while operating PK/384 (Lahore - Islamabad) Boeing 737 aircraft AP-BCE, No.1 thrust reverser light came on during climb. At Islamabad subject defect was rectified and subsequently the aircraft operated PK/319, PK/330 and PK/331 on 20th October, 1997. While operating PK/331 from Multan to Karachi No.1 Thrust Reverser Light again came "ON" during taxiing after landing at Karachi Airport (1115 hrs PST). The subject defect was handled by AME No.1141 Mr. Tanveer Sarwar and was unable to rectify the fault with the replacement of engine accessory unit and the defect was carried forward on MEL vide entry in Box No.22 of Tech Log (See Appendix 'L1'). Subsequently the aircraft was scheduled to operate PK/312 on 20th October, 1997 at about 1150 hrs PST i.e. 35 minutes after landing the aircraft was released on MEL to meet the flight scheduling requirements.
- 18.4. MEL Release "Star Marked". The operating Captain of PK/312 (Karachi - Lahore) on 20th October, 1997 did not accept the aircraft with its No.1 Thrust Reverser deactivated with MEL release due to actual weather - raining at destination. Captain made an entry in box No.25 of Tech Log and defect was "Star Marked" at 1150 hrs PST. (See Appendix 'L2').
- 18.5. The subject aircraft was withdrawn from PK/312 and was scheduled to operate PK/394 and PK/395 Karachi - MJD - Sukkur - Karachi on 20th October, 1997 at 1400 hrs PST after confirming that weather at destinations was clear. Mr. Tanveer Sarwar AME No.1141 made an entry to this effect in Tech Log Box No.25 with the consent of Manager Operations i.e. "Star Mark" is not applicable as destination weather is confirmed clear by M.C.C. (See Appendix 'L2').

- 18.6. Mr. Aftab Sheikh AME No.324. Chief Engineer Line Maintenance discussed the applicability of "Star Marked" entry made in the box No.25 of Tech Log with the manger operation engineering Mr. Mukhtar Choudhry. He explained to him that he is scheduling the subject aircraft to a different sector where there is no weather forecast for rain etc and Mr. Mukhtar agreed with him and scheduled the subject aircraft to operate PK/394 - 395 - 332 and 333 on 20th October, 1997 covering operations from Karachi - MJD - Sukkur - Multan. All flights operated successfully.
- 18.7. Mr. Aftab Sheikh further stated that on 21st October, 1997 subject aircraft operated PK/342 PK/343 and prior to release from Karachi weather at Faisalabad was checked through MCC. The aircraft after operating successfully to Faisalabad on its way back while landing at Karachi encountered wet runway conditions and went into the over-run area of runway 07L.
- 18.8. MEL - 78-01 "Thrust Reverser Systems". As per this MEL (See Appendix 'H') the B-737 aircraft can be despatched with one reverser inoperative with the following conditions.
- Note-1. All thrust reversers must be operative for T/Off from a runway having 0,08 inch or more of water, ice or slush.
- Note-2. All Thrust Reversers must be operative out of KHI, if Wx/forecast is snow, slush or .08 inch or more water on runway.
- 18.9. Crew Responsibilities. As per MEL preamble the captain has the authority to insist on the rectification of a defect even though it is covered under MEL, irrespective of the decision from Operators Headquarters. If Captain insists on rectifications, Captain will "Star Mark" the defect and put his signature. Star Marking will only be done by crew operating the out going flight. (See Appendix 'M').
- 18.10. Interpretation of MEL 78-01/"Star Mark". The views of some of the operational and maintenance staff on the interpretation of subject MEL and Star Mark implication are enumerated in the following paragraphs.
- 18.11. Captain Qamar Habib stated yes, it is permitted to land with one thrust reverser in operative when it is raining or when the runway is wet. Additionally according to his interpretation of item 1 Note 2 given on MEL No.78-01 the aircraft can land at Karachi with One Thrust reverser inoperative. However, both thrust reverser must be operative for any destination outside Karachi.

- 18.12. Mr. Arif Sajjad AME stated that as per Note 2 of B-737 aircraft MEL No.78-01 the aircraft is not suppose to land at Karachi under the conditions specified therein. He further stated that as per procedure a "Star Mark" in Tech Log is to be cleared by an AME prior to maintenance release for handing over the aircraft to the Captain.
- 18.13. Mr. Tanveer Sarwar and Mr. Waheedullah Khan AMEs stated that a Star Mark entry can be carried forward provided the conditions change under which the entry was "Star Marked" and the operating Captain accepts the aircraft.
- 18.14. Mr. Zaheer Akhtar AME stated that in his opinion once an MEL release is "Star Marked" the defect should have been rectified before next flight. He further stated that if a reported defect is covered under MEL all efforts to rectify the fault would be made before the departure of next flight. However, the flight would not be delayed if the defect is covered under MEL.
- 18.15. Mr. Asif Qadeer Manager Ops. Engineering-II stated that as per practice being followed by his seniors and his personal understanding of releasing an aircraft after a "Star Mark" entry has been made an aircraft can only be released after evaluating the circumstances under which "Star Mark" entry was made. He further stated that if all the conditions stipulated in supplemental procedure of MEL including weather forecast do not prevail then according to his understanding a star mark becomes void.
- 18.16. Mr. Sheikh Aftab Ahmed AME Chief Engineer Line Maintenance stated that in his opinion an engineer handling subject aircraft with Thrust Reverser discrepancy outside Karachi should have ensured that the weather forecast at Karachi was clear prior to release of subject aircraft. He further stated that preamble of B-737 MEL is silent on clearance of Star Mark entry without rectification. He also recommended that operation of an aircraft with Thrust Reverser defect should not be allowed under MEL.
- 18.17. Since many different views have been expressed on interpretation of B-737 aircraft MEL No.78-01 and on the clearance of Star Marked entry without rectification of defect, therefore a detailed discussion and analysis of this aspect will be carried out by the investigators under the heading of Analysis at a later stage of this report.
- 18.18. Flaps Stuck at 25 Degree. The Captain stated that on final approach when flaps were selected to 30 degree position the Co-Pilot informed him that the flaps were stuck at 25 degree which be validated. This discussion has also been

recorded on Cockpit Voice Recorder recovered from the aircraft. However, at the scene of accident the flaps were found at 40 degree because Captain during evacuation lowered the flaps to 40 degree. Therefore it appears that during flight due to some aerodynamic loads the flaps some times get stuck at 25 degree.

- 18.19. Flaps Defect History. On 16th October, 1997 Captain Syed Salim operated PK-351 on Boeing-737 Reg. No.AP-BCE and made an entry in Box No.83 of Tech Log that "On Approach Flaps Got Stuck at 25 degree" (See Appendix 'N1'). During ground test entire operation of flaps were carried out and found satisfactory. However, Tx and Ballnut were found dry and were lubricated. Tracks and rollers were also lubricated as preventive maintenance.
- 18.20. On 21st October, 1997 Captain Syed Saleem operated PK/337 and again made the same entry in Box No.40 of Tech log i.e. "during approach at Karachi Flaps were stuck at 25 degree when selected to 30 degree" (See Appendix 'N2'). Again thorough lubrication of all flaps tracks was carried out as per M.M. operation checked OK. After this repeat entry the aircraft flew one mission i.e. PK/342 on the same day and on the next mission i.e. PK/343 had the same problem on the final approach (accident aircraft).
- 18.21. A/S Control Box. Operation of A/S Control box was checked at PIAC inspection department. The unit was visually inspected and operation of unit was found satisfactory. Therefore, the reports confirmed that Auto Brake System was functioning satisfactorily. The report is placed at Appendix 'O'.
- 18.22. Weather Forecast. The weather forecast issued by Pakistan Meteorological Department Karachi Airport on 21st October, 1997 is placed at Appendix 'P'. This weather forecast is valid from 0600 Z (1100 PST) to 2400 Z on 21.10.1997 (0500 PST 22.10.1997) and covers the entire area from Islamabad - Lahore - Faisalabad - Multan - Sukkur - DG Khan - Karachi and all southern airfields. This Met report has forecast TSRA i.e. thunder shower and rain at all the places mentioned in the Met Forecast Report. On 21.10.1997 PK-336/337 (Karachi - DG Khan - Karachi) and PK-342/343 (Karachi - Faisalabad - Karachi) operated between 0800 Z to 1850 Z with No.1 Thrust Reverser inoperative (see Appendix 'Q'). Operation of these flights in the light of B-737 aircraft MEL No.78-01 (Note - 2) will be analysed later in this report.

18.23. Landing Field/Distance Required. As per load sheet calculations placed at Appendix 'K' the aircraft landing weight at Karachi Airport was about 48000 KG. With this landing weight and flaps selected at 30 degree position, approach speed of 135 knots and about 5 to 7 knots of head wind component the landing field length required for landing on WET runway was 4250 feet or total landing distance of 2550 feet ($4250 \times .6$) from threshold based on a reference condition where the aircraft is 50 feet over the threshold and touches down 1000 feet from the threshold without Thrust Reversers. (See Appendix 'R'). The accident aircraft under investigation was approaching at about 160 knots due to flaps getting stuck at 25 degree, gusty wind and turbulence weather condition. As per Boeing-737-300 aircraft flight manual performance chart placed at Appendix 'R', the landing field length required for landing on Wet runway was 5750 feet or total landing distance of 3450 feet ($5750 \times .6$) from the Threshold without thrust reverser. Therefore, according to this performance chart if the aircraft had touch down even at 7000 feet down the wet runway the pilot should have been able to stop before the end of 10500 feet long runway available at Karachi airport. Why the aircraft could not be stopped before the end of runway will be analysed later in this report.

18.24. DFDR Readout. The DFDR read out along with relevant calculations placed at Appendix 'F' revealed that the aircraft was steady on final approach heading of 070/071 for landing on runway 07L and maintaining approach speed 162 - 164 kts. The aircraft was at about 90 feet high over the threshold of runway 07L at a speed of 162.7 knots. The aircraft touch down at 160.7 knots and approximately 3100 feet down the runway. The aircraft IAS was 115 kts at 6921 feet down the runway (3821 feet from touch down). Pilot activated thrust reverser of No.2 engine at 8790 feet down the runway (5690 feet from touch down) when IAS was 90 kts. The reverser deployment was completed at about 80 kts and 9400 feet down the runway (6300 feet from touch down). The aircraft was maintaining runway heading upto this point. Aircraft heading is gradually changing from 073 to 077 degree within a distance of about 1000 feet. At the end of runway 07L the aircraft was at 66 knots and heading had changed very abruptly from 078 to 087 to 096 to 105 to 114 in about 5 seconds and then from 114 to 126 to 167 to 210 degree in about 4 seconds and aircraft gone past the end of runway 07L by about 600 feet in the stopway area.

19. ANALYSIS

- 19.1. Boeing-737 aircraft Reg. No.AP-BCE while landing on Wet runway at Karachi airport was maintaining approach speed of about 160 kts due to flaps getting stuck at 25 degree and presence of gusty wind and turbulent weather conditions. The aircraft touch down about 3100 feet down the runway at about 160 kts. As per Boeing 737-300 aircraft flight manual performance chart placed at Appendix 'R' while landing on wet runway if the aircraft is approaching at 160 knots the total landing distance required without thrust reverser is 3450 feet ($5750 \times .6$) from runway threshold if touch down is 1000 feet down the runway. However, when aircraft touch down is at 3100 feet down the runway than the aircraft should have come to a stop at 5550 feet down the runway. ($3100 - 1000 = 2100$ feet additional touch down distance + 3450 feet landing distance required). Therefore, to determine as to why the Pilot could not stop the aircraft within the performance limits of the aircraft, will be discussed and analysed in this report.
- 19.2. With a view to understand as to why the aircraft could not be stopped it is considered appropriate to discuss the phenomenon of Hydroplaning and its associated problems during landing under these conditions.
- 19.3. Hydroplaning. The tyre and ground friction produces large forces that are essential both for maintaining directional control and stopping the aircraft. The presence of contaminants such as WATER, ICE, SNOW or SLUSH on the runway surface disrupts the contact between the tyre foot prints and the pavement and interferes with the development of friction forces. As a tyre rolls along a wet runway, it is constantly squeezing water from under the tread. This squeezing action generates water pressure which can lift portions of the tyre off the runway and reduce the amount of friction the tyre can develop. This action is call Hydroplaning, so technically when ever a tyre is moving on a wet runway, it is hydroplaning. This results in tyre/ground friction which can be low at high speeds and improves as speed reduces.
- 19.4. Aircraft's Hydroplaning Speed. The general accepted 'rule of thumb' for determining an aircraft's hydroplaning speed is $9 \times$ under root of the tyre pressure (P) in Lb/in. But it is only correct when applied to wheels which have spun - up to full speed, and it represents the full hydroplaning speed. Once hydroplaning has started, the wheels spin - down and stop fairly rapidly. However, if ground speed is reduced, the time for the wheels to spin - up again is much longer and hydroplaning will persist to a lower speed ($7.7 \times / P$)

than that given by the above formula. Additionally, because hydroplaning is a progressive phenomenon, significant losses in braking effectiveness and directional control will occur below this speed - how much depends upon runway surface, texture, tyre condition, amount of water on the runway, fluid density, tyre inflation pressure, tyre tread design, bogie undercarriage wheel arrangement i.e. front wheel and rear wheels and grooves on runway surface.

19.5. Basic Approach to Hydroplaning Problem. To alleviate potential problems caused by inadequate runway friction there exist basically two possible approaches.

- (a) Provision of reliable aircraft performance data for take off and landing related to available runway surface friction/braking action.
- (b) Provision of adequate runway surface friction at all times and under all environmental conditions by constructing runway with modern standards/designs.

19.5.1. The first concept (a) which improves safety has proved impracticable mainly because of the problems of determining runway friction characteristic in operationally meaning full terms; and additionally the problem of correlation between braking test devices used on the ground and aircraft stopping performance. This applies in particular to the wet runway cases.

19.6. Aircraft Certification Requirement. There are no regulations requiring a manufacturer to demonstrate the airplane's stopping performance on wet or slippery runways during the certification process or to provide data relating to such performance. However, the operating rules require that the minimum length of runway needed for landing be extended by 15 percent when the runway is forecast to be wet.

19.7. Landing On Wet Runways. Boeing-737 aircraft Operations Manual provides a recommended procedure for landing B-737 aircraft on Wet or Slippery runway. The main focus of this procedure is on maintaining approach speed recommended for the existing conditions and plan for a firm touch down 1000 feet down the approach end of the runway. It also says that while it is important not to land long, it is more important not to land short of the runway. The runway 07L at Karachi Airport is Non Instrument Approach Runway and there is a tendency by the pilots to make a approach higher than the Instrument Approach heights where pilot fly final approach on the glide path. The procedure also says that if a touch down far down the runway is likely, consider a

go-around. Therefore, the option of go-around is on the judgment of the pilot keeping in view the available runway and the calculated total landing distance. The Captain of the B-737 aircraft under investigation made a touch down 3100 feet down the runway 07L and as per Airplane Flight Manual Performance Chart placed at Appendix 'R'. The aircraft should have come to a stop at 5550 down the runway as mentioned earlier in para 19.1. The procedure also recommends that immediately after touch down select reverse thrust as they are most efficient at high speed and will decrease wet runway stopping distance. Extremely wet and slippery condition can result in longer distances than indicated. On the subject of adverse weather landing the Chief Pilot Technical PIAC had received an article from Boeing Airliners which was circulated to alert the crew on the problems associated during Landing on Slippery Runway.

- 19.8. Landing On Slippery Runway. Boeing article on the subject high light the phenomenon of hydroplaning, problems associated during hydroplaning, use of stopping systems - spoilers, thrust reversers and wheel brakes on slippery runway and their effectiveness. On wet runway the total stopping force available is less than on dry runway due to the reduced braking effectiveness. The reversers and spoilers become more important since they now represent a larger proportion of the total force capability. With the spoilers deployed, the drag and reversers furnish 80 percent of the high speed stopping force, whereas the brakes furnish 70 percent of the low speed stopping force. Even as per this article landing on wet runway without the use of thrust reverser results in a stopping distance that is two time the reference dry runway distance. The aircraft under investigation required about 3000 feet of stopping distance on Dry runway calculated from runway threshold. Therefore, on wet runway it should have been about 6000 feet from runway threshold. If the touch down is at 3100 feet down the runway the aircraft should have come to stop at 8100 feet down the runway. (3100 - 1000 + 6000). Therefore, it appears that B-737-300 aircraft performance chart can not provide reliable data related to available runway conditions due to reasons already mentioned in para 19.5.
- 19.9. Analysis of MEL No.78-01. As mentioned is paras 18.10 to 18.17 that different people have different interpretation of this MEL. The investigators are of the opinion that Note - 2 of this MEL is not worded appropriately as such it is not understood or interpreted correctly. Besides, there are some more observations on the Note - 2 of this MEL.

Note-2: All thrust Reversers must be operative out of KHI, if Wx/forecast is snow, slush or .08 inch or more water on runway.

- (a) The word "Out of KHI" is being interpreted by some people that while departing Karachi the Wx/forecast is applicable for landing at destination other than Karachi and is not applicable if aircraft is landing at Karachi.
- (b) Note-2 covers two weather situations i.e. actual weather and forecast weather. If .08 inch or more water is on the runway than it is actual weather. But to forecast that .08 inch or more water will be on the runway is a difficult to forecast that accurately.
- (c) If there is a standing water on the runway, who is going to find out accurately as to how much is the water depth. It may be possible when it is not raining and runway is available for such measurement.
- (d) However, when it is raining and runway is operational and water depth on the runway can not be measured than how a pilot is going to find out before landing as to how much water is present on the runway.
- (e) If information about water depth on the landing runway is not available than what kind of decision a pilot is expected to take while landing.
- (f) Karachi Airport has slopping runway and general impression is that this allows for more rapid drain off and prevention of water accumulation deep enough to cause Hydroplaning. However, it is difficult to derive an equation connecting rain fall rate, runway slope and water depth with a view to establish that at the time of landing there is going to be .08 inch or more water on runway.
- (g) The note-2 of MEL No.78-01 says that both Thrust Reversers must be operative if wx/forecast is .08 inch or more WATER on runway and has not used the phrase WHEN IT IS RAINING or RAIN IS FORECAST. This provides an opportunity to engineering and Operations Engineering Staff to release the aircraft with one thrust reverser inoperative even when there is a forecast for thunder shower and rain and let the captain do his

calculations of measuring the water depth of .08 inch or more on the runway at the time of landing. Due to same reasons the aircraft with "Star Marked" entry had been released and scheduled for flying.

(h) On 21st October, 1997 (day of accident) there was a forecast for thunder storm and rain from 1100 hrs PST (21.10.97) to 0500 hrs PST (22.10.97) covering vast area in the Southern and Northern part of the Country. (See Appendix 'P'). In spite of this weather forecast, PK-336, PK-337, PK-342 and PK-343 were scheduled to operate with One Thrust Reverser inoperative due to the reasons mentioned in the para (g) above and the captain of PK-343 while landing at Karachi Airport during rain was required to determine the water depth on the runway and then make a decision to land or divert to some other destination.

(j) Therefore keeping in view the above facts/observations, it is considered necessary to review the MEL No.78-01 of B-737 aircraft.

19.10. Captain's Awareness of Runway Conditions. The captain of PK-343 before landing at Karachi Airport was aware that it was raining and runway was wet. The braking action Medium to Poor as reported by different types of aircraft landed prior to PK-343 was passed to the captain for his information and necessary planning. However, no skiddometer reading was taken by the ATC to measure the braking action as the runway was not available because of air traffic movements. The runway friction passed by landing aircraft is of course a guide line for the pilot about the runway condition, but pilot will make his own decision for landing or diversion keeping in view the Total Landing Distance Required on Wet runway as per Airplane Flight Manual Performance Chart and total runway length available.

19.11. Captain's Decision to Land. The captain was maintaining a final approach speed of about 155-160 knots due to flaps getting stuck at 25 degree position, gusty wind and turbulent weather conditions. The captain after studying the B-737 aircraft landing performance chart made a decision to land, because as per this chart for landing on wet runway with final approach speed of 160 knots the landing field length required was 5750 feet and total landing distance required was 3450 feet from thresh hold without Thrust Reversers. (See Appendix 'R'). Keeping in view these field length requirements captain had very large safety margin for

landing at Runway 07L at Karachi. Even with touch down at 3100 feet down the runway the aircraft should have come to a stop at 5550 feet down the runway. Why the aircraft could not be stopped within the performance limits of the aircraft has already been discussed and analysed in detail in paras 19.3 to 19.8.

20. Findings

- 20.1. PIA aircraft B-737 Reg.No.AP-BCE operating scheduled domestic flight PK-343 from Faisalabad to Karachi on 21st October, 1997 while landing on wet runway 07L at Karachi airport went into the over-run (stopway) area and came to a stop about 650 feet from the end of runway and to the right edge of stopway in the Kutcha area on a heading of 210 degree.
- 20.2. All 95 passengers and 8 crew members on board the aircraft were safe and disembarked the aircraft through L1 door using the steps.
- 20.3. B-737 aircraft sustained substantial damage as a result of the accident.
- 20.4. The aircraft was fully certificated and had been maintained as per laid down standards.
- 20.5. The pilots were properly certificated and authorized for the flight. Captain Qamar Habib ALTP No.667 was the Pilot-in-Command and First Officer Muhammad Isa CPL No.1668 was the Co-Pilot.
- 20.6. The same aircraft on 20th October, 1997 operated as PK-331 from Multan to Karachi and after landing (1115 hrs PST) at Karachi airport the Captain made an entry in Tech Log that "No.1 Thrust Reverser Light Came on during Taxing". The subject defect was handled by Mr. Tanveer Sarwar AME No.1141 and was unable to rectify the fault and defect was carried forward on Minimum Equipment List (MEL) see Appendix "L1".
- 20.7. Subsequently the same aircraft was scheduled to operate PK-312 (Karachi - Lahore) on 20th October, 1997 with its No.1 Thrust Reverser deactivated.
- 20.8. The Operating Captain of PK-312 did not accept the aircraft with its No.1 Thrust Reverser deactivated (MEL release) due to actual weather - raining at destination. Captain made an entry in Tech Log and defect was "Star Marked" at 1150 hrs (PST) on 20th October, 1997. See Appendix "L2". (35 MINUTES AFTER LAST LANDING THE AIRCRAFT WAS RELEASED ON MEL TO MEET THE FLIGHT SCHEDULING REQUIREMENTS).

Note:- As per MEL preamble if captain insists on rectification, captain will STAR MARK the defect and put his signature. See Appendix "M".

- 20.9. The aircraft was withdrawn from PK-312 and was scheduled to operate PK-394 and PK-395 as the weather at destination was clear.
- 20.10. Mr. Tanveer Sarwar AME No.1141 made an entry in Tech Log with the Consent of Manager Operation Engineering Mr. Mukhtar Choudhry i.e. 'STAR MARK IS NOTE APPLICABLE AS DESTINATION WEATHER IS CONFIRMED CLEAR BY M.C.C. See Appendix "L2".
- 20.11. Mr. Aftab Sheikh AME No.324 Chief Engineer Line Maintenance discussed about the Star Marked entry with Manager Operation Engineering and both were of the opinion that Star Mark is not applicable when weather at destination is clear.
- 20.12. As per MEL No.78-01 (See Appendix "H") the B-737 aircraft can be despatched with One Thrust Reverser Inoperative. However, Note-2 of this MEL says that all thrust reverser must be operative out of KHI, if wx/forecast is snow, slush or .08 inch or more water on runway.
- 20.13. Different views have been expressed by the operational and engineering staff on the interpretation of subject MEL and on the clearance of STAR MARKED entry without rectification of defect. See paras 18.10 to 18.17.
- 20.14. The Note-2 of this MEL is not worded appropriately as such it is not understood or interpreted correctly. The deciding factor for release of aircraft with one thrust reverser inoperative is presence of or forecast of .08 inch or more water on the runway. The word rain or rain forecast has not been used in this MEL for making a decision for release of aircraft with one reverser inoperative.
- 20.15. One 21st October, 1997 there was Met forecast for thunder shower and rain from 0600Z-2400Z (Appendix "P"). PK-336/337 and PK-342/343 operated during this period with one reverser inoperative. Technically speaking the release of aircraft and acceptance by the captains of these flights was correct as there was no mention of .08 inch or more water on the runway at the time of landing at their destination airfields.
- 20.16. Captain Qamar Habib operated PK-343 (Faisalabad - Karachi) on 21st October, 1997 the weather reported at Karachi was raining and surface wind 360 degree 15 to 20

knots. Runway 07L was in use for landing which is Non Instrument Approach Runway.

- 20.17. Captain was maintaining a final approach speed of about 155 - 160 kts due to flaps getting stuck at 25 degree position, gusty winds and turbulent weather conditions.
- 20.18. The braking action from Medium to Poor as reported by different types of aircraft landed just before PK-343 was passed to the Captain by the DATCO. However, no skiddometer reading could be taken as runway was not available due to air traffic.
- 20.19. The captain after studying the B-737 aircraft landing performance chart made a decision to land keeping in view the total landing distance required for landing on wet runway without thrust reversers and total runway length available.
- 20.20. The total landing distance required was 3450 feet from threshold when touch down its 1000 feet down the runway.
- 20.21. Captain was making a landing on Non Instrument Approach Runway 07L and there is a tendency by the pilots to make a approach higher than the instrument approach height. This resulted in touch down at 3100 feet down the runway.
- 20.22. As per performance chart (Appendix "R") with touch down at 3100 feet down the wet runway the aircraft should have come to a stop at 5550 feet down the runway without the use of Thrust Reversers.
- 20.23. Due to presence of standing water on the runway the aircraft experienced the phenomenon of Hydroplaning which resulted in significant losses in braking effectiveness. The Thrust Reverser become more important since they now represent a larger proportion of the total stopping force capability.
- 20.24. As the aircraft was operating with one thrust reverser inoperative therefore, captain could not use the major stopping force effectively.
- 20.25. The solution to the potential problems caused by hydroplaning requires provision of reliable aircraft performance data for take off and landing related to available runway surface friction and braking action. The reliable performance data can not be produced keeping in view the problem of determining runway friction characteristics in operationally meaningful terms.

- 20.26. Karachi Airport has slopping runway and general impression is that this allows for more rapid drain off and prevention of water accumulation deep enough to cause hydroplaning.
- 20.27. Since correct information about water depth on the landing runway is not available, therefore, it is difficult for the pilot to make a good decision for landing or diversion keeping in view the conditions laid down in Note-2 of MEL No.78-01 i.e. all thrust reversers must be operative if .08 inch or more water is on the runway.

21. Causes of Accident

- 21.1. Release of B-737 aircraft Reg.No.AP-BCE for scheduled domestic flights with a STAR MARKED entry which required rectification of the defect when aircraft was released vide MEL No.78-01 with No.1 Thrust Reverser Inoperative.
- 21.2. The subject aircraft was released and accepted by the captain of the aircraft as the Note-2 of MEL No.78-01 is not worded appropriately as such not understood or interpreted correctly by the operational and engineering staff.
- 21.3. Captain Qamar Habib while landing at night on wet runway did not make a touch down at 1000 feet down the runway as per recommended procedure instead he touch down 3100 feet down the runway and aircraft could not be stopped as per aircraft performance chart due to presence of water on the runway that resulted in significant losses in braking effectiveness and directional control due to Hydroplaning phenomenon. Non availability of Thrust Reverser which represents a larger proportion of total stopping force further aggravated the situation and aircraft could not be stopped before the end of runway 07L.

22. Recommendations

- 22.1. Director Maintenance and Engineering PIAC should ensure that all possible effort is made by the engineering staff on duty to rectify the defect reported by the captain after landing at the Base Maintenance facility of that aircraft before releasing the aircraft on MEL.
- 22.2. Director Flight Operation PIAC should ensure that all captains are aware of Operational and Technical Consequences while accepting the aircraft with inoperative equipment/system covered by the MEL. However, keeping in view the planned mission requirements/schedules, if considered necessary in the interest of Flight Safety, the

captain must exercise his authority and insist on the rectification of a defect even though it is covered under MEL.

- 22.3. Director Maintenance and Engineering PIAC must ensure that the aircraft with Star Marked entry in Tech Log is not released for flight till such time the defect has been rectified.
- 22.4. Director Flight Operation PIAC to brief all pilots that they must make positive effort to fly the correct approach with a view to touch down 1000 feet down the wet runway as exact runway surface friction may not be available due to various limiting factors as mentioned in this report.
- 22.5. Director Flight Operation PIAC should plan regular lectures by a specialist for educating all the pilots on the hazards of landing on contaminated runways highlighting the problems associated with phenomenon of hydroplaning and effectiveness of various stopping system - spoilers, thrust reverser and wheel brakes etc.
- 22.6. Chief of Flight Standard CAA is to review the B-737 aircraft MEL No.78-01 "Thrust Reverser Systems" and make recommendations to DG CAA for its cancellation in consultation with DFO and DAW keeping in view the importance of thrust reversers while landing on wet runway.

APP. B



APP. 'BI'



APP. B2



APP. B3



APP. 'B4'



APP. 'B5'



APP. B6



APP. B7



APP. 'B8



APP. 'B9'

