3 Conclusion

SUMMARY

General background:

The A/C was serviceable at take off and was operated within the approved limitations.

The crew members held appropriate licenses and were qualified for this flight.

There was no indications of specific concerns about the flight or any tension between the crew members

1. Airplane Performance Evaluation:[1]

Note:

The evaluation is based on factual information (FDR data and CVR recorded information) and the data gathered during the investigation

1.1 Simulation procedure

Based on the FDR data, a kinematic consistency (KINCON) process was used to supplement the FDR data and calculate additional parameters to be used in the performance analysis. Additional simulation was conducted using the Boeing M-Cab facility.

Analysis of the simulation results showed the following:

- The motion of the control surfaces showed consistency with the recorded motion of the control inputs, with the exception of control wheel (because of the unreliable recorded parameter)

- The results obtained from the M-Cab tests indicate that the computed parameters are quite sensitive to the values of the used input parameters.

1.2 Weight and Balance

Although the average weight for passenger used in Load and Trim sheet for the Weight and Balance calculation was not the one given in the airline Flight Operations Manual, none of the available data relevant to the airplane weight and balance showed evidences of airplane loading abnormality. Computations of the airplane weight, c.g. location, stabilizer setting and the Take Off speeds V1, VR, V2 were correct.

[1] See section 2.2 Airplane Performance Evaluation

1.3 Analysis of radar data

An examination of the radar data and the FDR data showed that the path of the accident airplane as derived from the radar data is consistent with the path as derived from the FDR date

2. Analysis

2.1 Airplane systems behavior[2]

No failure or abnormal behavior was found in the following systems:

- Environmental Control System (ECS)
- Fire Fuel system
- Landing Gears
- Engines
- APU.

Thus, a possible contribution of these systems to the accident could be ruled out. Within the technical area, only “Flight Controls” and “Auto Flight” could have contributed to the accident

2.2 Crew behavior[3]

Evidence of distraction possibly becoming spatial disorientation is observed from the time of start of right turn until the announcement of aircraft turning right, after which it is unclear whether the captain recovered or remained in the state of spatial disorientation. After the call “No autopilot commander”, the crew behavior appears normal.

[2] See section 2.3 Analysis of Airplane systems behavior
[3] See section 2.6 Crew Behavior

3. Analysis of the chronological main events:[4]

Based on the facts collected about the flight, as well as the aircraft and the flight crew, a fault tree was established and examined in details, which lead to the ruling out of a number of possible conditions for the accident. Only a few of such conditions could not be ruled out and are reflected hereafter (organized according to the fault tree structure)

3.5 Roll back towards wing level[5]

The following conditions could not be ruled out:

- Pilot widening departure pattern (intentional control action)
- To level wings prior to engaging autopilot (intentionally)
- Pilot loses awareness of heading or bank (unintentional)
- Anomalies with the lateral control system

The investigation could not determine a higher possibility to any of the above findings based on the given data.

[4] See section 2.5 Anaysis of the chronological main events

[5] Numbering is consistent with the Fault tree structure numbering. Refer to Chapter 2 Analysis

3.7 Autopilot engage sequence

The following conditions could not be ruled out:

- Captain requests autopilot, F/O pushes CMD button anyway
- Captain requests autopilot, Captain prompts F/O due slow response, F/O pushes CMD button
- Captain pushes CMD button, gets no response. PF questions no response and makes second push. F/O reports autopilot engaged.

The investigation could not determine a higher possibility to any of the above findings based on the given data.

3.8 Mode change from HDG SEL to CWS-R

The following conditions could not be ruled out:

- Autopilot Engagement with FD Roll Bar > 7 Degrees (with time lag) (no failure condition)

3.9 Aileron move in direction of right roll

- Pilot input
- Lateral system fault:

The investigation could not determine a higher possibility to any of the above findings based on the given data.

3.10 Autopilot Disengagement indications on the FDR and CVR

The following conditions could not been ruled out:

- Automatic Disconnect Interlock invalid
- Manual Disconnect

The investigation could not determine a higher possibility to any of the above conditions based on the given data.

3.11 Airplane begins roll to right

G- Lateral control system:

G.1. Pilot input:

G.1.1 Following FD, FD Commands Erroneous, Erroneous Selected Heading Data

G.1.2 Loss of Situational Awareness

G.2 Autopilot Initiated

G.2.2 Uncommanded (actuator faults only)

G.3- Lateral System Fault

G.3.6 Trim/Feel Unit Fault

3.13 Right roll continues to overbank with ailerons activities

The following conditions could not be ruled out

1. NA

2. Lateral Control System

2.1 Conditions related to pilot input: (See section2.6)

2.1.1 Following Erroneous EADI, Alternate Instruments Not Cross-Checked

2.1.2 Loss of Situational Awareness, Captain experiences SD Type II

2.1.3 Loss of Situational Awareness, Captain misinterprets ADI indications

2.2 Conditions related to Autopilot:

2.2.1 Autopilot Actuator Hardover Fault

2.3 Conditions related to Lateral System Faults:

2.3.1 Trim/ Feel Unit Fault.

2.3.2 Temporarily, Spoiler wing cable jam (Spoiler offset of the neutral position)

2.3.3 Temporarily, F/O wheel jam (spoilers offset of the neutral position)

The investigation could not determine a higher possibility to any of the above conditions based on the given data.

3.14 Flight crew CVR autopilot announcements

1. Requests for Autopilot Engagement

2. Announcement of Autopilot Status (Announcement of "Autopilot in Command" made by the F/O):

3. Announcement of "No autopilot commander" made by the F/O:

4. Announcement of Perceived Autopilot Behavior

5. Requests for Autopilot Disengagement

The investigation could not determine a higher possibility to any of the above conditions based on the given data.

3.15 Rapid left roll towards wings level

1- Capt. Upset Recovery Attempt

2- First Officer Upset Recovery Attempt

3- Joint Upset Recovery Attempt

From the above, Captain Upset Recovery Attempt seems a higher possibility

3.16 Impact with water

Although an attempt to correctly recover was initiated, the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery.

FINDINGS

3.1 Possible causes :

- Trim/ Feel Unit Fault (Aileron Trim Runaway)
- Temporarily, Spoiler wing cable jam (Spoiler offset of the neutral position)
- Temporarily, F/O wheel jam (spoilers offset of the neutral position)
- Autopilot Actuator Hardover Fault

3.2 Possible contributing factors :

- A distraction developing to Spatial Disorientation (SD) until the time the F/O announced “A/C turning right“with acknowledgement of the captain.
- Technical Log copies were kept on board with no copy left at departure station.
- Operator write up of defects was not accurately performed and resulting in unclear knowledge of actual technical status
- There are conflicting signals which make unclear whether the captain remained in SD or was the crew unable to perceive the cause that was creating an upset condition until the time when the F/O announced that there was no A/P in action.
- After the time when the F/O announced “no A/P commander” the crew behavior suggests the recovery attempt was consistent with expected crew reaction, evidences show that the corrective action was initiated in full, however the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery.

3.3. Additional findings:

- The ECAA authorization for RAM B737 simulator was issued at a date later than the date of training for the accident crew although the inspection and acceptance test were carried out at an earlier date.

- Several recorded FDR parameters were unreliable and could not be used for the investigation.

CONCLUSION

No conclusive evidence could be found from the findings gathered through this investigation to determine a probable cause. However, based on the work done, it could be concluded that any combination of these findings could have caused or contributed to the accident.

Although the crew at the last stage of this accident attempted to correctly recover, the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery.

4. Recommendations:

Manufacturers- Operators:

1. Joint effort should be made to minimize MEL-CDL-DDL allowances to avoid lowering safety standards by overloading pilots, and ensure that whenever found necessary to maintain such items, very clear procedures addressing pilots and maintenance crews to be made available
2. Efforts should be made to enhance the function and reliability of FDR and CVR due to the importance of the data obtained to the safety of the aviation industry
3. Clear engagement status indication for the autopilot should be made available to the crew to avoid any possibility of incorrect perception or ambiguity.
4. Based on data collected from different operators using this autopilot and the number of reports of unexpected autopilot behavior some of which are unexplained, re-assessment of this autopilot system is recommended and operators should be made aware of any problems and manufacturers analysis actions and recommendations.

Civil Aviation Authority

5. Ensure that all operators strictly adhere to CAA regulations and requirements, especially in remote stations

Pilot Training:

Emphasis should be made in pilot training on the following:

6. Early detection and recognition of conditions that could lead to upset condition.
7. Timely and appropriate recovery action from upset conditions to counteract sudden unknown abnormal conditions.

Human Factors:

8. Recommend in depth studies of the Spatial Disorientation, ways of early recognition between crew members and appropriate crew action to overcome it and increase crew awareness of this phenomena
9. Although a level of CRM was observed, it is clear that more emphasis in this area of training will achieve earlier recognition and recovery from abnormal conditions

Attachments

Comments from participating parties

MCA response to U.S. Comments

Reference: U.S. Summary Comments on Draft Final Report of Aircraft Accident
Flash Airlines flight 604, Boeing 737-300, SU-ZCF
January 3, 2004, Red Sea near Sharm El-Sheikh, Egypt

SUMMARY:

U.S. Comment: [1]

During the investigation, the accident investigative team, which consisted of Egyptian, French, and U.S. investigators, adopted a "scenario tree" methodology to determine the accident sequence of events. As part of this methodology, the investigative team identified possible accident scenarios, and sufficient evidence existed for the team to rule out most of the identified scenarios. The team then examined the remaining scenarios and the evidence collected during the investigation to determine which scenario most likely explained the accident sequence of events.

MCA response:
Both the “scenario trees” addressing the systems and the Human issues as agreed upon by the different parties participating in the accident investigation have been fully included in the report. These scenario trees which were based on factual information included in the factual report and agreed upon by all parties were used as the basis for the analysis.

The MCA’s position is that the scenarios that could not be ruled out must all be considered as possibilities. Trying to speculate a more likely scenario does not comply with standard investigative practices.

U.S. Comment:

The only scenario identified by the investigative team that explained the accident sequence of events and was supported by the available evidence was a scenario indicating that the captain experienced spatial disorientation, which resulted in his making inadvertent actions that caused the accident. The remaining scenarios and possible causes were not consistent with the evidence and did not explain the sequence of events identified by the investigative team.

Specifically, no evidence of any airplane-related malfunction or failure was found. The exhaustive examination of the 737's autopilot and lateral control systems identified no fault that could explain the airplane's motion during the accident flight. In fact, as the MCA's draft final report properly concludes, the accident airplane's motion is consistent with the flight control movements recorded on the flight data recorder.

MCA response:

Referring to the Fault tree analysis (13.0 Right roll Continues to overbank with aileron activity), it could be noted that the analysis did not lead to the above conclusion. Also, the analysis does not

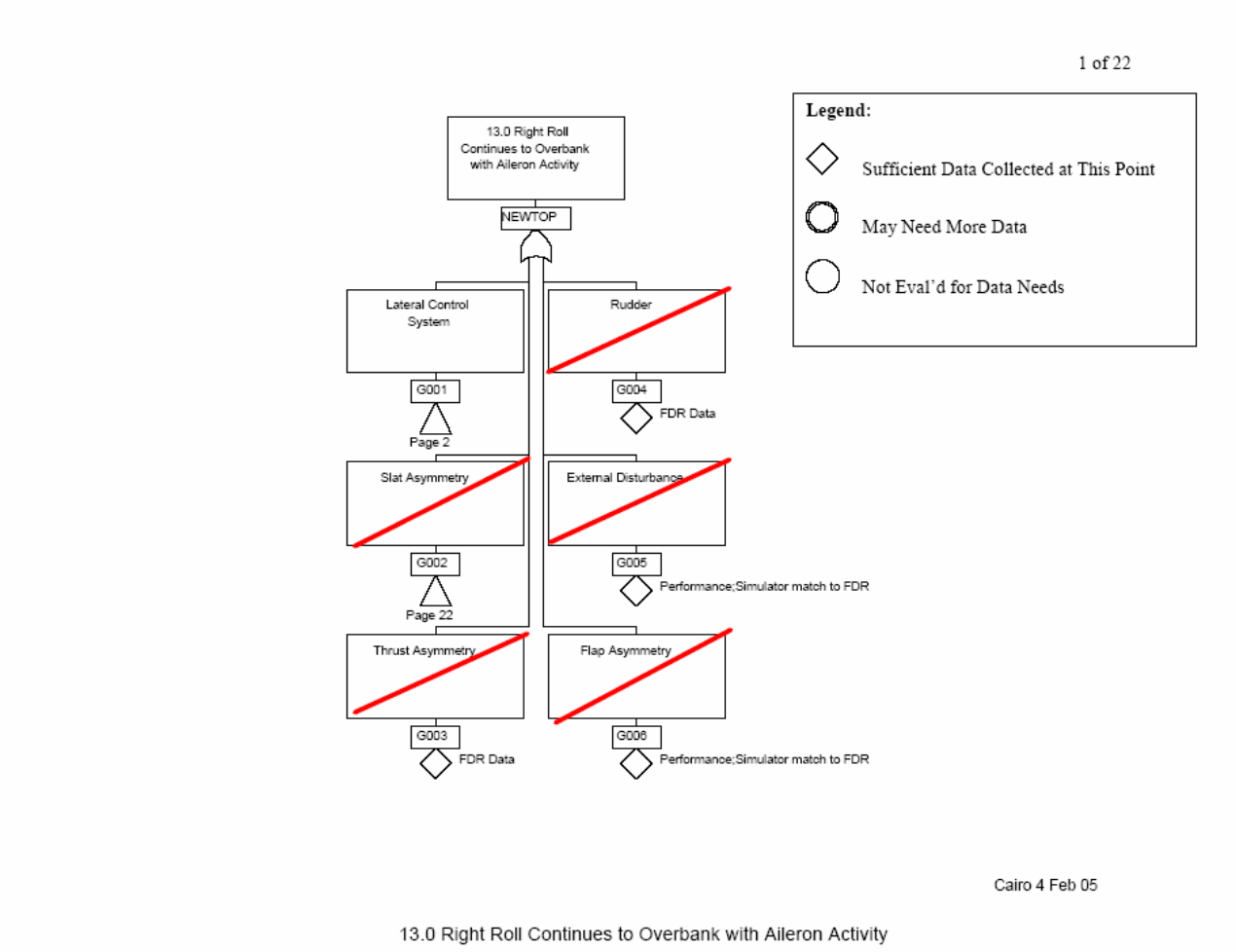
[1] U.S. comments are shown in Italian with yellow background

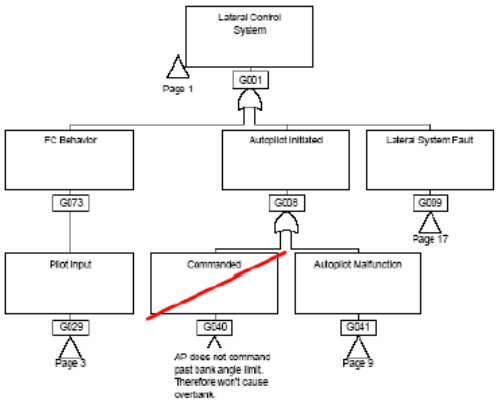
support the above U.S. statement. Had this been the case, these scenarios would have been ruled out as the rest of scenarios considered by the fault tree.

With regard to the statement that there was supporting evidence that the captain experienced spatial disorientation is inaccurate to say the least. The investigation team studied this scenario extensively, numerous conflicting evidences appeared leading to the MCA adopting the position that no conclusive evidence could be found to explain this accident

The Fault Tree that was developed and agreed upon by the participating investigation parties addressing the probable causes included in the Report are shown hereafter, including the scenarios that could not be ruled out due to their level of consistency with the available factual data.

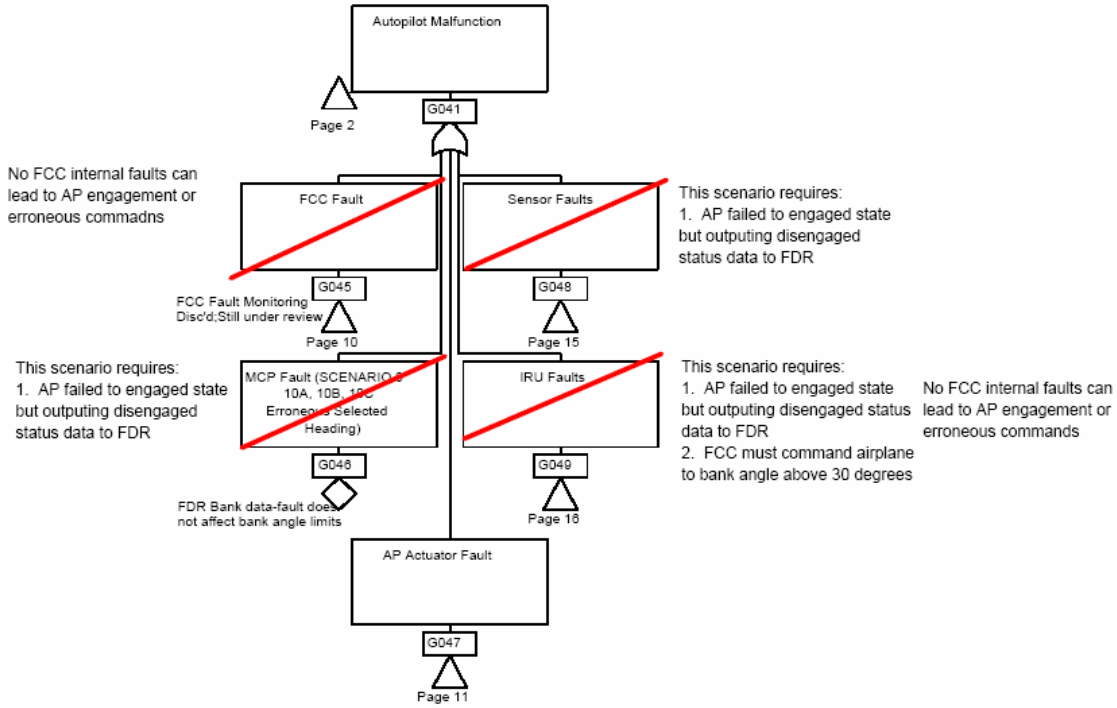
1- Autopilot Actuator Fault (Actuator Hardover without Force Limiter 17 to 20 lb Force) was not ruled out (refer to pages 1, 2, 9 and 11 of the fault tree)





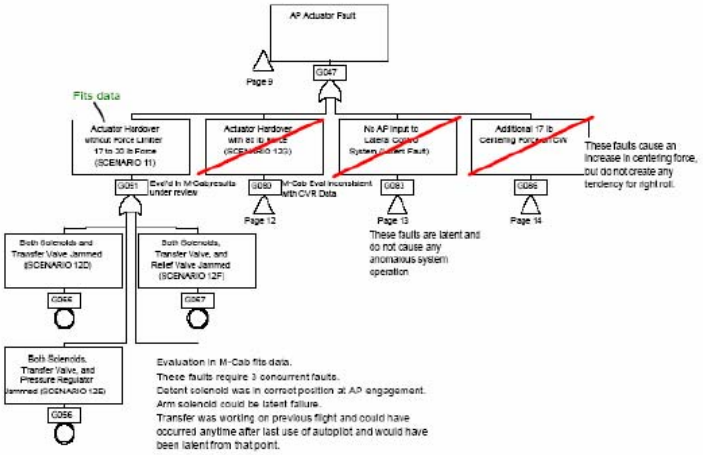
13.0 Right Roll Continues to Overbank with Aileron Activity

N.B.
For the "Lateral System Fault" block, See Appendix 2-1 lateral control analysis



Cairo 4 Feb 05

13.0 Right Roll Continues to Overbank with Aileron Activity

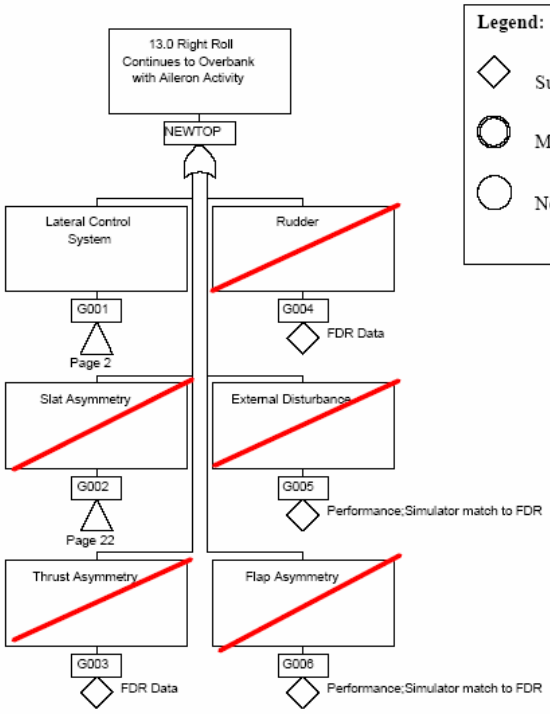


Cairo 4 Feb 05

13.0 Right Roll Continues to Overbank with Aileron Activity

N.B.
For the "Actuator Hardover without Force Limiter 17 to 20 lb Force (SCENARIO 11)" block, See Appendix 2-1 lateral control analysis

2- Trim/Feel Unit Fault was not ruled out (refer to pages 1, 2, 17, 20 of the fault tree)



Legend:

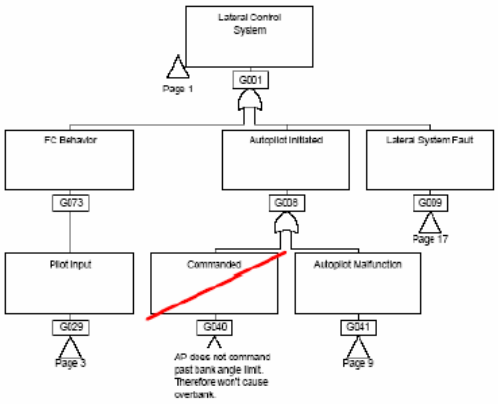
Sufficient Data Collected at This Point

May Need More Data

Not Eval'd for Data Needs

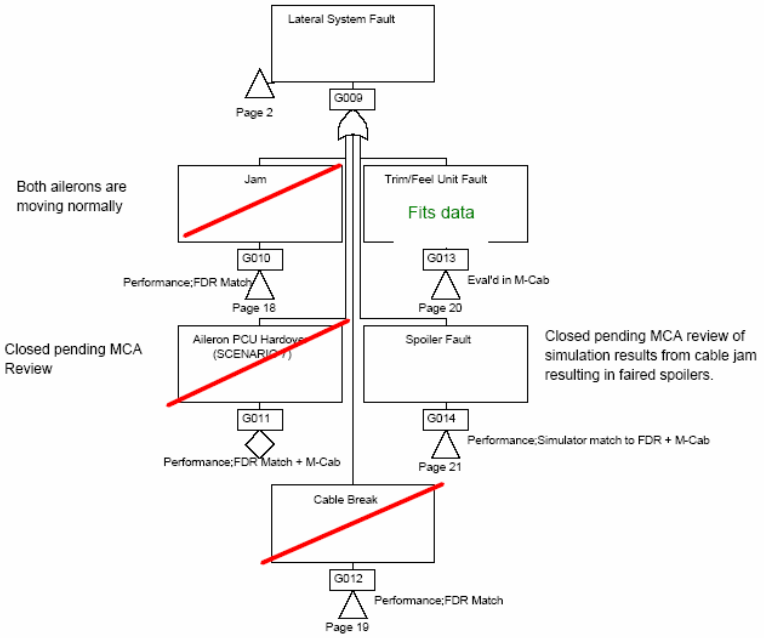
Cairo 4 Feb 05

13.0 Right Roll Continues to Overbank with Aileron Activity



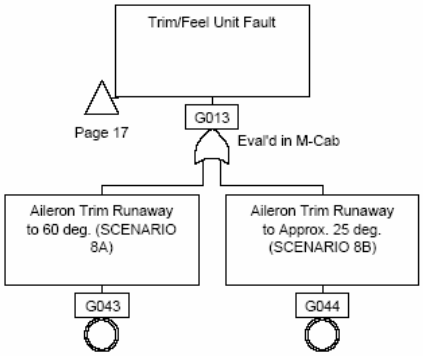
13.0 Right Roll Continues to Overbank with Aileron Activity

N.B.
For the "Lateral System Fault" block, See Appendix 2-1 lateral control analysis



Cairo 26 Aug 05

13.0 Right Roll Continues to Overbank with Aileron Activity



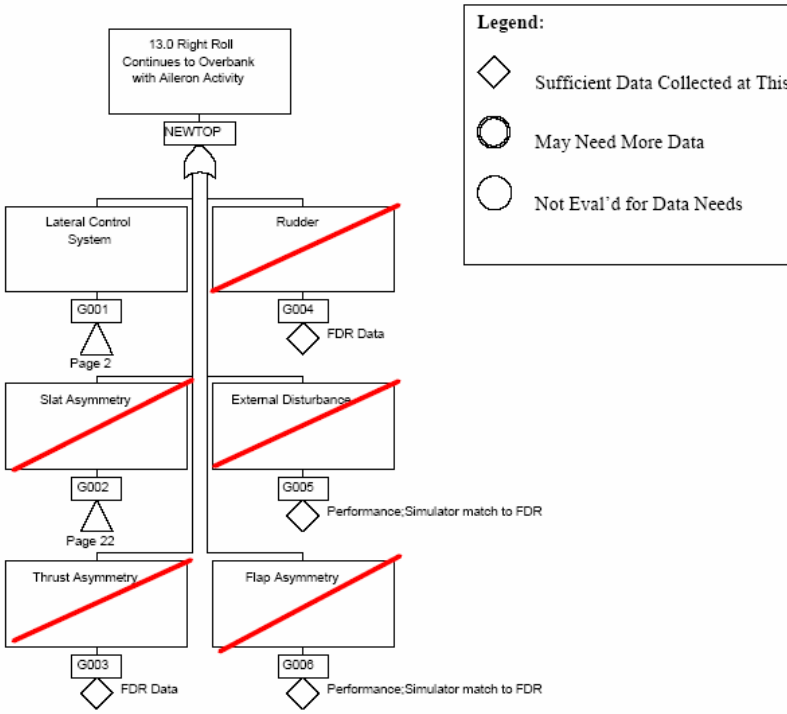
Evalutation in M-Cab fits data. However, trim fault must have occurred after autopilot engagement (zero force, zero aileron engagement indicates zero trim at that point).

Review ROV videos for trim actuator.

Cairo 4 Feb 05

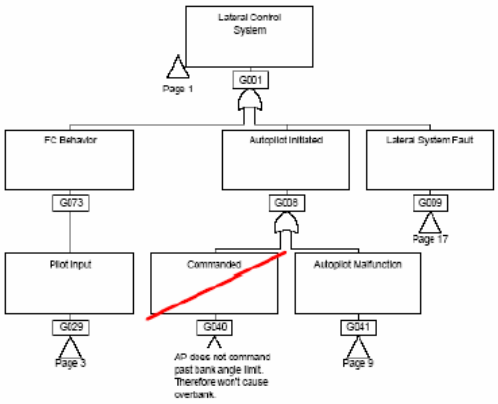
13.0 Right Roll Continues to Overbank with Aileron Activity

3- Spoilers wing cable jam and F/O wheel jam were not ruled out (refer to pages 1, 2, 17, 21 of the fault tree)



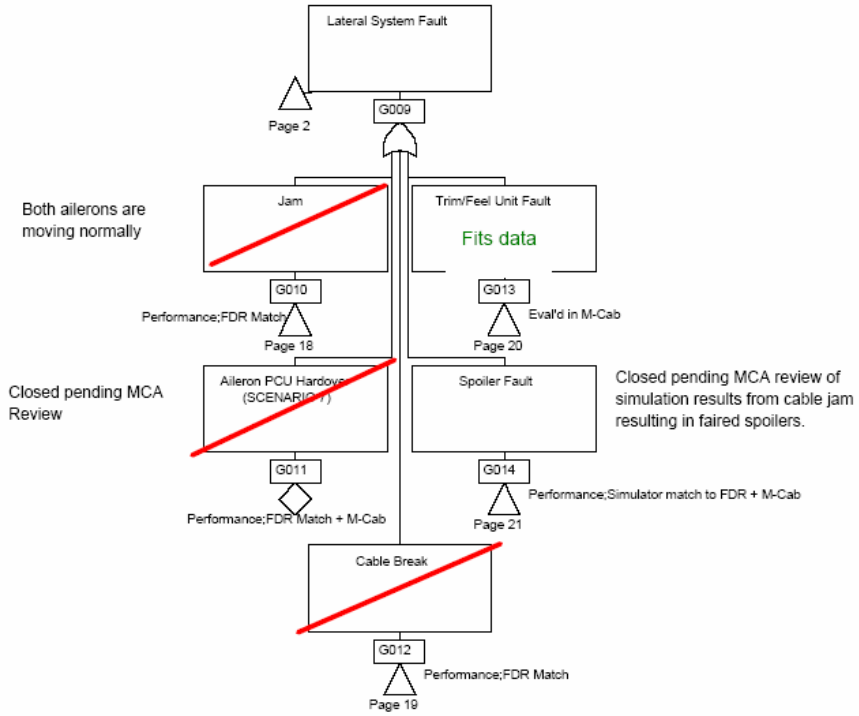
Cairo 4 Feb 05

13.0 Right Roll Continues to Overbank with Aileron Activity



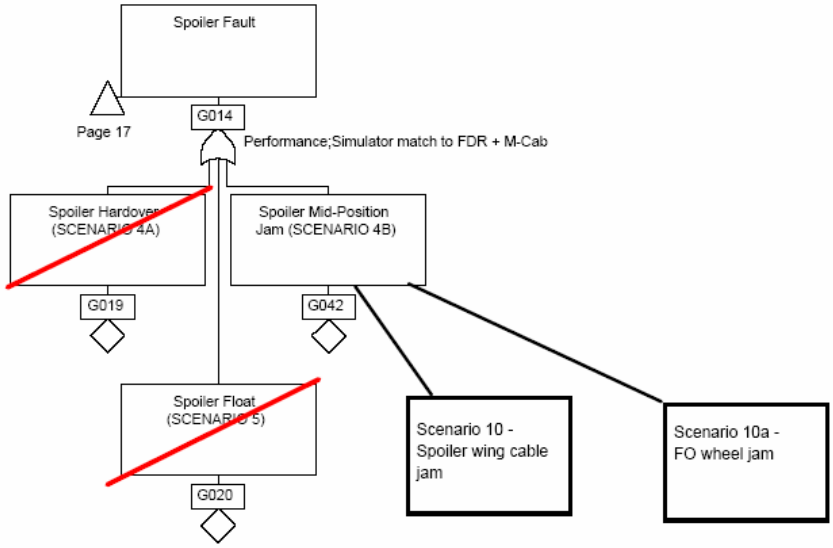
13.0 Right Roll Continues to Overbank with Aileron Activity

N.B.
For the "Lateral System Fault" block, See Appendix 2-1 lateral control analysis



Cairo 26 Aug 05

13.0 Right Roll Continues to Overbank with Aileron Activity



Cairo 26 Aug 05

13.0 Right Roll Continues to Overbank with Aileron Activity

U.S. Comment:

SUMMARY (continue)

The MCA's draft final report stated, "no conclusive evidence could be found from the findings gathered through this investigation to determine a probable cause." Instead, the draft final report offered a list of findings, including "possible causes," even though the identification of possible causes is not consistent with international protocol concerning aviation accident investigations. Specifically, International Civil Aviation Organization Annex 13, paragraph 3.2.5, stipulates, "a list of possible causes should not be given." The report also indicated that "any combination of these findings could have caused or contributed to the accident." Three of the four possible causes identified in the MCA's draft final report were an aileron trim fault, an autopilot actuator fault, and a spoiler jam, none of which were supported by the evidence collected during the investigation.

MCA response:

- MCA does not agree with U.S. statement because, had this been the case, these scenarios would have been ruled out as well. On the contrary they were not ruled out because of their level of consistency with the available factual data.

U.S. Comment:

SUMMARY (continue)

The MCA' s investigation of the operational and human factors related to the accident was minimal. Further, its documentation of the captain's training history and performance and issues related to flight crew proficiency, fatigue, and crew resource management (CRM) were not fully developed and analyzed in the draft final report, despite being pertinent to the circumstances of the accident. If the MCA had obtained additional information about these areas, the investigative team could likely have identified specific corrective actions that would prevent recurrence.

MCA Response:

- The “scenario trees” addressing the Human issues as agreed upon by the different parties participating in the accident investigation have been fully included in the report. This scenario tree was used as the basis for the analysis.

U.S. Comment:

SUMMARY (continue)

This letter provides the U.S. investigative team's position on the cause of this accident, which is consistent with the available evidence, and an overview of the primary areas of concern with the MCA's draft final report. The attachment to this letter provides comments and suggests specific corrections, clarifications, and/or additions for each area of concern in the draft final report. As discussed further in this letter, the. U.S. investigative team concludes the following:

1. *no evidence indicated that an airplane-related malfunction or failure caused or contributed to the accident,*
2. *the aileron inputs and the corresponding right roll precipitating the upset resulted from inadvertent flight crew inputs,*
3. *the captain experienced spatial disorientation as the right roll inputs occurred, (4) the first officer did not assume timely control of the airplane, and*
4. *the airplane remained fully controllable and responsive to the flight controls throughout the flight.*

MCA Response:
Refer to the following analysis

U.S. Comments:

1- No evidence indicated that an airplane-related malfunction or failure caused or contributed to the accident.

To fully evaluate the role of the airplane and its systems in this accident, the investigative team relied on evidence such as cockpit voice recorder (CVR) and flight data recorder (FDR) information and flight performance and simulation evaluations. The operating aspects and potential failure modes of the various systems were also reviewed. Evidence from the investigation does not indicate that a failure of the airplane's autopilot or lateral control systems occurred. Further, during flight simulator evaluations, Egyptian, French, and U.S. investigators were able to maintain airplane control with relatively minor inputs during the demonstrations of all but one of the simulated system failures. This simulated failure involved a quintuple failure within an autopilot actuator that would result in an uncommanded roll input and require up to 80 pounds of control wheel force to overcome. FDR, CVR, and flight simulations data showed no evidence that such a failure occurred.

During subsequent meetings of the investigative team, the MCA presented numerous additional system failure scenarios for consideration. Factual evidence presented during these meetings and in follow up correspondence with the MCA and discussions between team members and MCA personnel eliminated all but two of these scenarios from consideration. The hypothetical failures that could not be fully ruled out because of a lack of associated data were the possibility that an aileron trim runaway had occurred or that an uncommanded autopilot flight control actuator hardover fault had occurred. Analysis of FDR data and simulation studies of the effects of these two failure scenarios (each of which required two or more system failures) indicated that it is highly improbable that these failures occurred. Further discussion of these two hypothetical failures follows.

Aileron trim runaway. The MCA' s draft final report accurately stated that an aileron trim runaway had not occurred before the autopilot was disconnected. After the autopilot was disengaged and as the airplane continued to roll to the right, FDR data showed aileron deflection rates well in excess of the aileron trim actuator rate of 0.6° per second. The rates recorded by the FDR could only have been achieved through manual wheel input because they exceeded the capabilities of the aileron trim system. Further, during flight simulations in Boeing's Multipurpose Engineering Cab (M-cab) simulator, investigators easily identified and controlled the aileron trim runaway and demonstrated that only 15 pounds of control wheel force were required to return to and maintain the aileron surfaces at the neutral position.

MCA Response:

Aileron trim runaway:

Reference:
Section 2.5.13 Right roll continues to overbank with ailerons activity, item 6.3.4.2 of the Report (Aileron Trim Runaway to 60 deg. Scenario)

Assumptions:

- One trim switch stuck at closed position (a latent failure), the second trim switch has stuck at closed position with trim input from the flying crew, leading to trim motor hardover position driving the ailerons to 15 degrees (maximum trim authority) towards right turn.
- This failure is assumed to occur after autopilot disconnect.

Consequences of the hypothetical failure:

- The aileron trim actuator will reach its hardover position driving the ailerons to 15 degrees (maximum trim authority) at no load on the aileron control wheels.
- Both aileron wheels will be driven away from the neutral position when released.
- The ailerons and flight spoilers will always follow the aileron wheels.
- The new position for the wheel will be about 65 degrees at no load on the aileron control wheels. The force-wheels relation will change (refer to Figure 2.5.13.7 Ailerons and spoilers behavior with aileron trim actuator at its hardover position)
- Whenever the aileron wheels are released, the wheels will move to the hardover position (65 degree).
- The ailerons wheels will always follow each others simultaneously.
- No cockpit light or aural warning will support identifying this fault
- The Captain and F/O will be able to resist the trim action and control the ailerons and spoilers but with additional force (Refer to Fig Figure 2.5.13.7)
- Whenever the Captain and F/O release the ailerons control wheels, the ailerons will tend to move towards right turn unless one of the flying crew exerts forces on the aileron control wheels to restore the airplane attitude.

Results of the M-Cab test (This test was done on Boeing M-Cab, Seattle, Washington):

M-Cab results confirmed the analytical studies for the failure.

This fault could not be ruled out, based on the following:

- The results obtained from the analytical studies and the M-Cab test show a very close consistency with the available data.

- The airplane behavior is consistent with the consequences of the hypothetical fault:

    1. The ailerons movements towards airplane right roll are highly consistent with the expected position resulted from this hypothetical fault.

    2. This fault always drive the airplane in the right roll direction

    3. Movement of the aileron surfaces as shown in the FDR towards the neutral position are consistent with captain attempts to control the airplane attitude with the existence of the failure, the rate of airplane rolling to the right is always reduced with these attempts. The forces required to move the ailerons by the captain are higher than the forces required in normal condition with no fault.

    4. Whenever the captain control wheel is released, the ailerons move towards the offset position showing high consistency with the fault existence. The fault was continually driving the airplane towards more right roll

    5. At the end of the flight, the FDR shows considerable aileron movements towards the wing level condition, which are consistent with crew inputs (attempt) to control the airplane attitude with the existence of the failure (forces are higher than normal to overcome the centering springs). Based on evaluation in M-Cab, this event fits the data. However, trim fault must have occurred after autopilot engagement (zero force, zero aileron engagement indicates zero trim at that point). This hypothetical condition

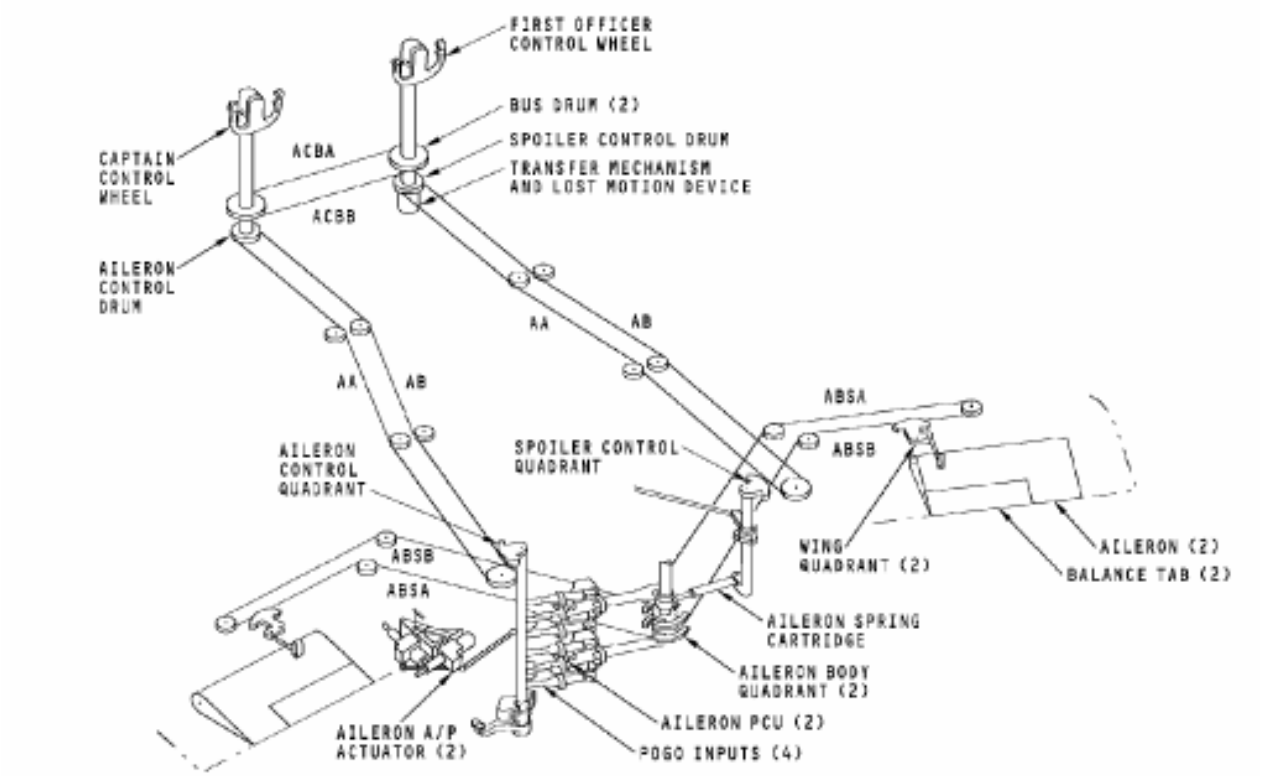
shows close consistency with the event. This condition is also consistent with the possibility of recovering the airplane when appropriate quantity of input is applied timely on the airplane.

6. The movements of the ailerons throughout the last recovery phase highly support this scenario. The FDR data shows that even with the captain attempt to recover the airplane at the last stages, the ailerons always had the trend to move towards the opposite direction of correction which is highly consistent with the fault existence when the captain effort to restore the airplane is reduced.

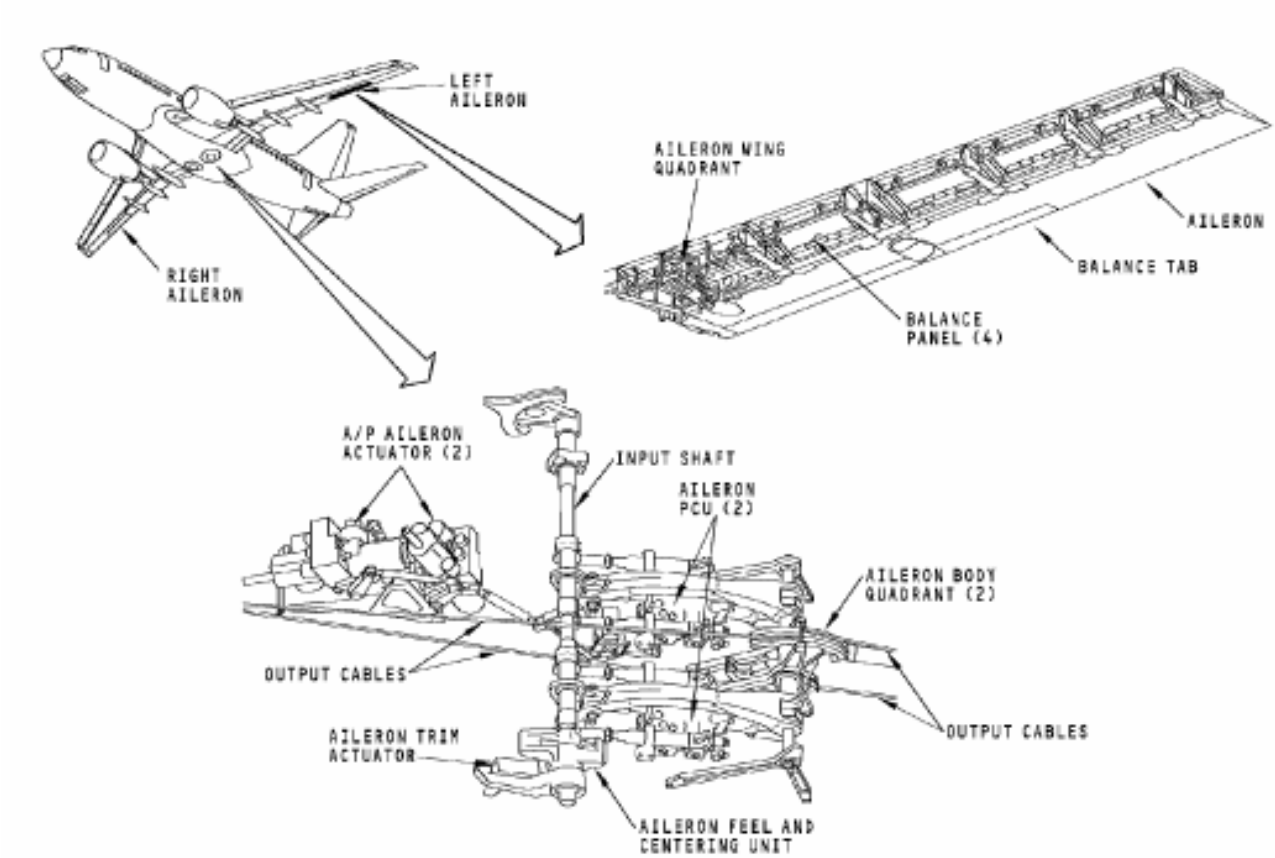
7. Referring to U.S. comments, it is stated that *"The rates recorded by the FDR could only have been achieved through manual wheel input because they exceeded the capabilities of the aileron trim system which is 0.6 degrees"*. The max rate is meaningful only if the aileron control wheels are released. If the aileron wheels are held firmly and not released, the aileron trim runaway will not cause any movement to the ailerons, only an induced increasing force will be generated on the control wheels. Wheel forces are not recorded in the FDR. The moment the aileron wheels are released, the aileron wheels and the ailerons will immediately move to the new trimmed condition. Based on the above analysis, the MCA does not agree with the U.S. comment

8. Crew behavior study does show consistency.

9. Although an attempt to correctly recover was initiated, the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery within the available remaining time before impact.



AILERON AND AILERON TRIM CONTROL SYSTEM - GENERAL DESCRIPTION 2



AILERON AND AILERON TRIM CONTROL SYSTEM - COMPONENT LOCATIONS 2

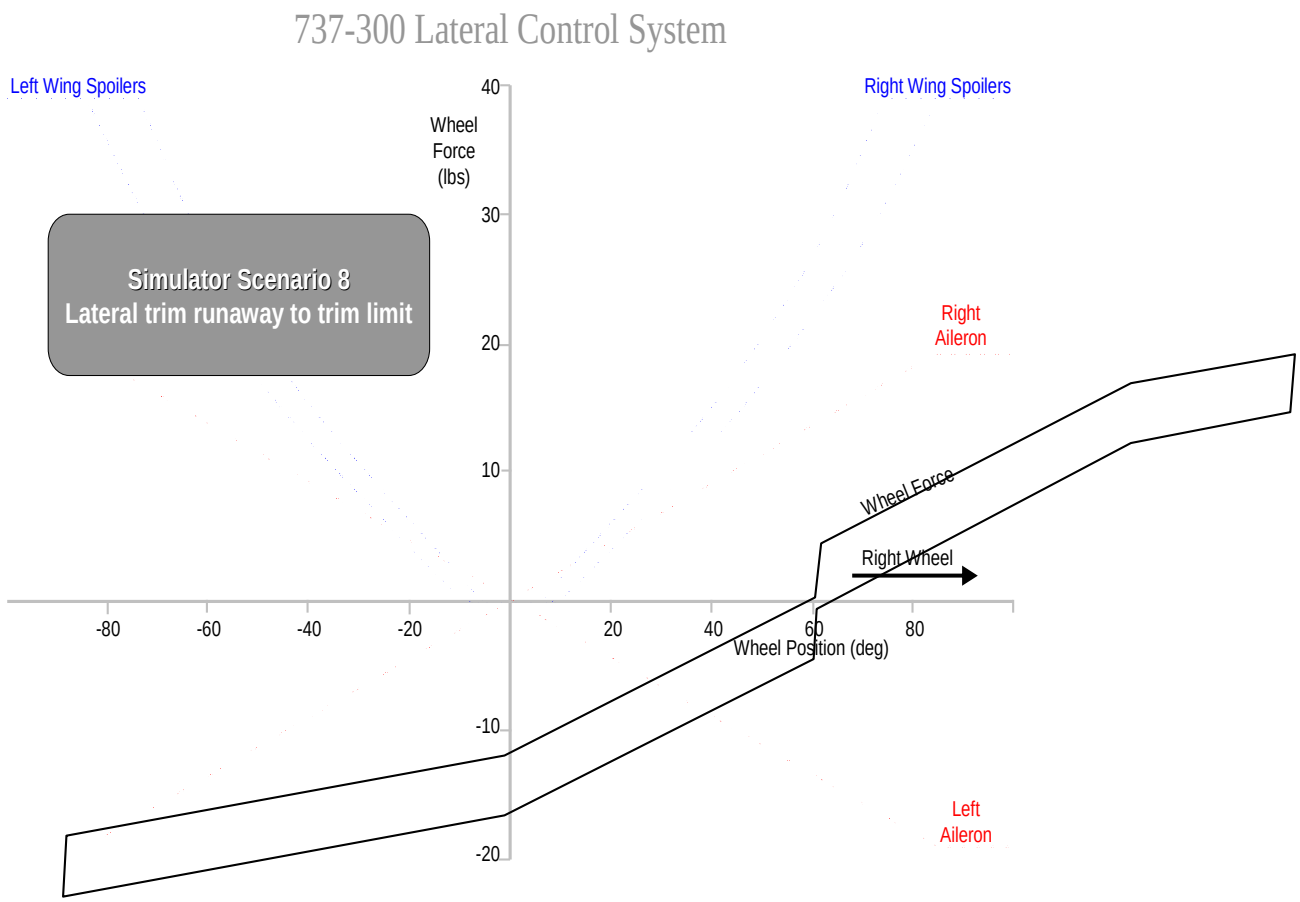
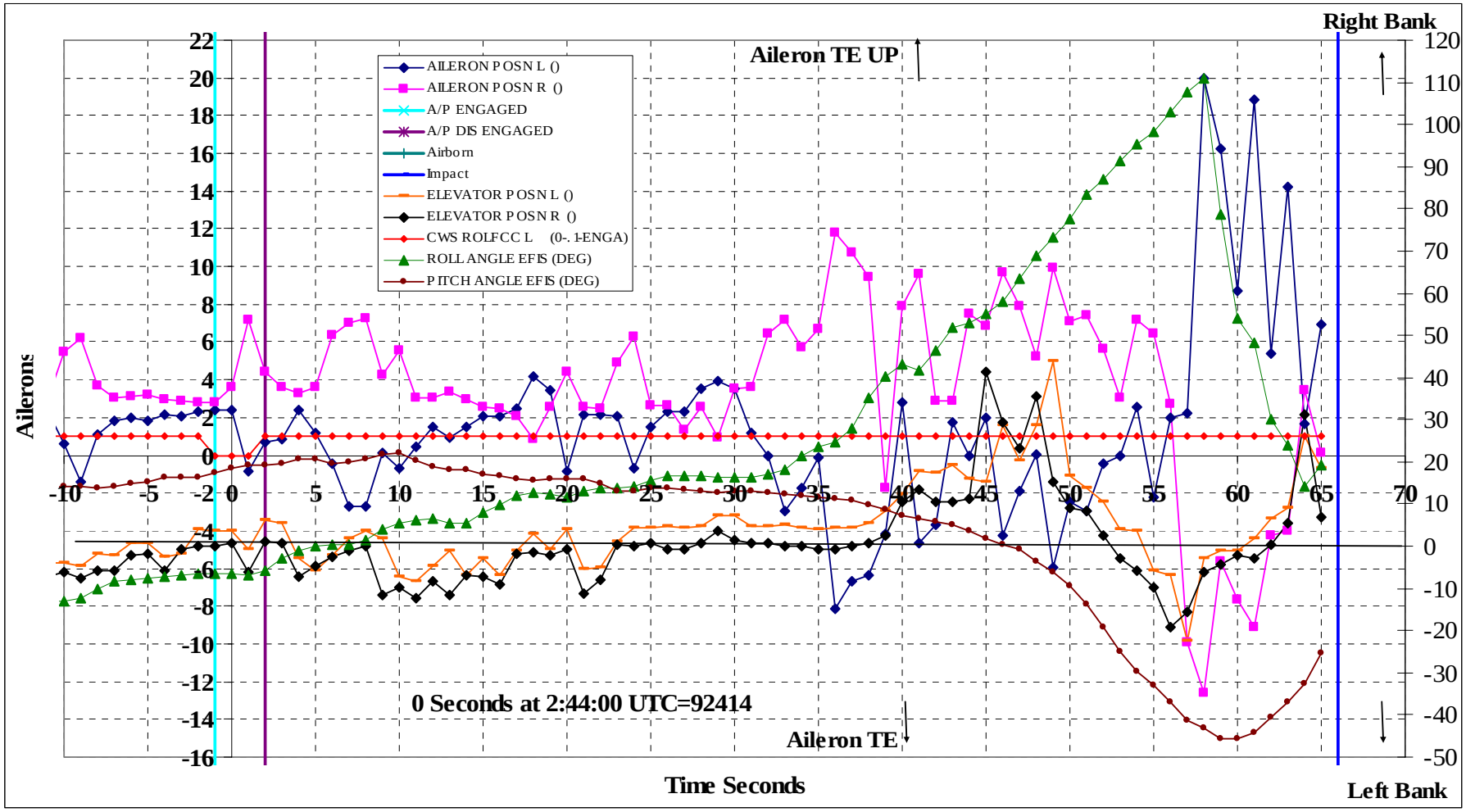
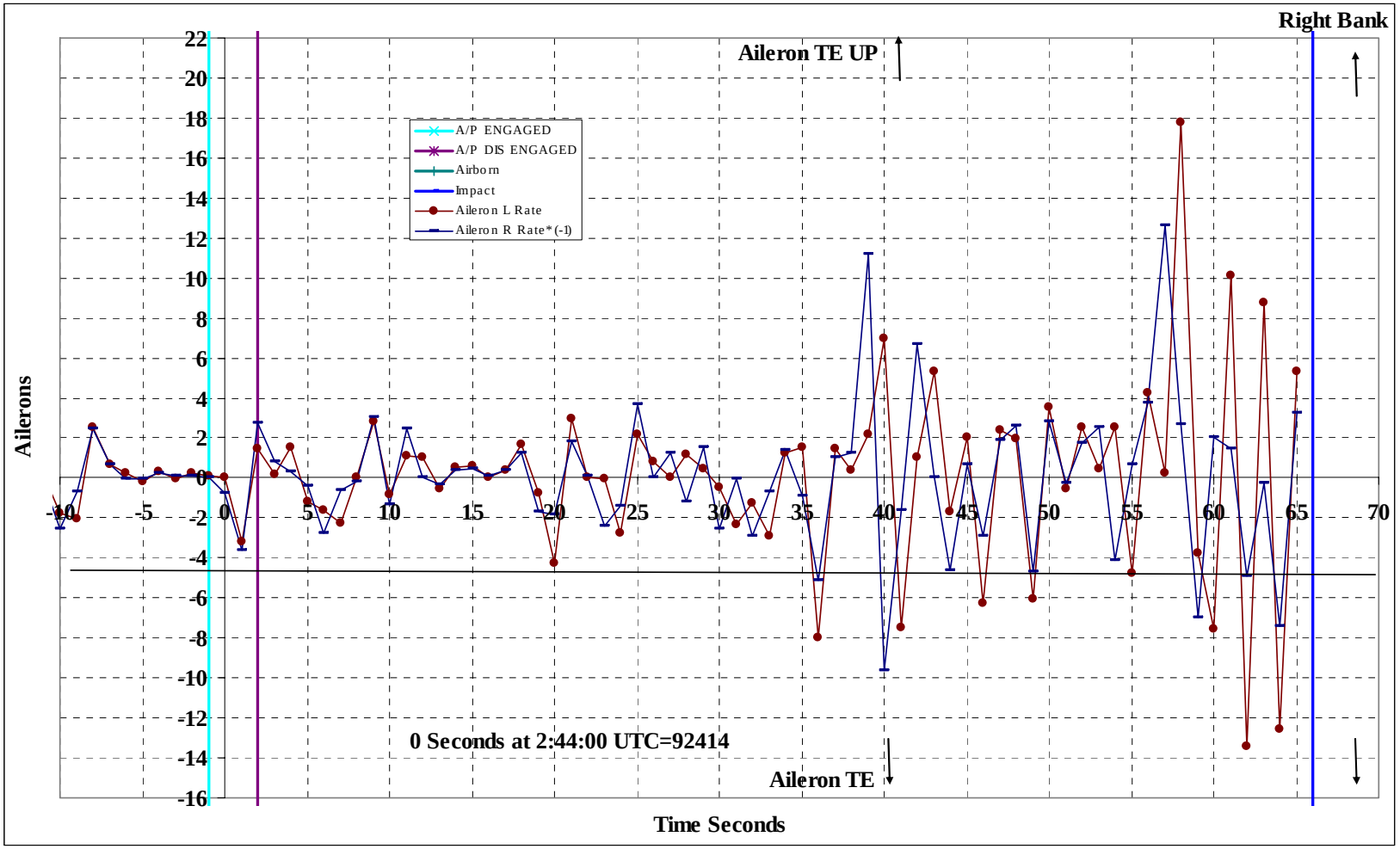


Figure 2.5.13.7 Ailerons and spoilers behavior with aileron trim actuator at its hardover position



Ailerons Movement- FDR data



Derived Aileron Rate[2]

[2] Using the average linear rate before and after each point, the right aileron rate is sign inverted for comparison

U.S. Comment:

Autopilot flight control actuator hardover. The MCA's draft final report accurately stated that an aileron autopilot flight control actuator hardover most likely had not occurred. An autopilot flight control actuator can only provide an uncommanded aileron control system input if three separate faults occur simultaneously within the actuator: the arm solenoid must be commanded open, the detent solenoid must be commanded open, and the transfer valve spool must be jammed off center. This failure scenario would result in a hardover to the autopilot actuator authority limit, ultimately commanding the aileron surfaces to a maximum position of ±15° and the control wheel to 60° (in the absence of manual input). The effects of this failure scenario were inconsistent with the FDR data. Further, during M-cab flight simulations, investigators easily identified and controlled the hardover and demonstrated that only 17 to 20 pounds of control wheel force were required to counter the hardover effects.

MCA Response:

Reference:

Section 2.5.13 Right roll continues to overbank with ailerons activity, item 6.2.2.3.1.1 Both Solenoids and Transfer Valve Jammed (Autopilot actuator, both Solenoids and Transfer Valve Jammed (Actuator Hardover without Force Limiter 17 to 20 lb Force)) (section 2.5.13) of the Report

Assumptions:

- These faults require 3 concurrent faults. Detent solenoid was in correct position at autopilot engagement. Arm solenoid could be latent failure. Transfer was working on previous flight and could have occurred anytime after last use of autopilot and would have been latent from that point.
- Both the Arm and the Detent solenoid are assumed to fail (stuck open). The transfer valve is assumed to fail in the position commanding right bank

The cause of these failures can not be conclusively identified. However the failure of the arm solenoid (stuck open solenoid) might have been the result of a stuck closed contact (MCP engage relay A). Also these failures might be the result of an electric short within the electrical socket on the autopilot actuator.

Consequences of the hypothetical failure:

- This triple fault will result in an A/P actuator hardover.
- The crew will not be able to engage the autopilot.
- With autopilot disengaged, the affected autopilot actuator will always try to drive the ailerons and spoilers towards the actuator hardover position, driving the airplane towards airplane right roll direction. Both aileron wheels will be driven away of the neutral position and will be positioned at about 60 degrees wheel position, The Captain and the F/O will be able to control the ailerons and flight spoilers with an additional force of 17 lbs to overcome detent piston pressure and override the autopilot actuator.
- The ailerons and flight spoilers will follow movement of the ailerons control wheels.
- Whenever the control wheels are released, the control wheel will tend to return to the relevant autopilot actuator hardover position (60 degrees wheel position), resulting in an aileron deflection of about ± 13 degrees and spoilers deflection and driving the airplane towards airplane right roll direction.
- This fault will not be associated with any visual indication or audio warning in the cockpit

Results of the M-Cab test (This test was done on Boeing M-Cab, Seattle, Washington):

M-Cab results confirmed the analytical studies for the failure. Therefore, the MCA does not agree with the U.S. comment that this is not consistent with the FDR data".

MCA agrees with the U.S. statement that "*Further, during M-cab flight simulations, investigators easily controlled the hardover and demonstrated that only 17 to 20 pounds of control wheel force were required to counter the hardover effects" provided that the failure is well recognized and anticipated..*"

MCA does not agree with the U.S. comment that "*the fault was easily identified by the investigators"* for the following reasons.

- This fault is not associated with any visual or audio warning in the cockpit.
- This failure is not included in the FCOM (Flight Crew Operating Manual)
- This failure is not included in any airplane training phase.

This fault could not be ruled out, based on the following:

- The results obtained from the analytical studies and the M-Cab test show a very close consistency with the available data.

- The airplane behavior is consistent with the consequences of the hypothetical fault:

    1. The ailerons movements towards airplane right roll are highly consistent with the expected position resulted from this hypothetical fault.

    2. This fault always drive the airplane in the right roll direction

    3. Movement of the aileron surfaces as shown in the FDR towards the neutral position are consistent with captain attempts to control the airplane attitude with the existence of the failure, the rate of airplane rolling to the right is always reduced with these attempts. The forces required to move the ailerons by the captain are higher than the forces required in normal condition with no fault.

    4. Whenever the captain control wheel is released, the ailerons move towards the offset position showing high consistency with the fault existence. The fault was continually driving the airplane towards more right roll

    5. The movements of the ailerons throughout the last recovery phase highly support this scenario. The FDR data shows that even with the captain attempt to recover the airplane at the last stages, the ailerons always had the trend to move towards the opposite direction of correction which is highly consistent with the fault existence when the captain effort to restore the airplane is reduced.

    6. The Captain repeated announcement "Autopilot" and the F/O announcement "Autopilot is engaged commander" support this hypothetical scenario and

indicating that the autopilot was still interfering and driving the airplane not the way it should be in the normal conditions.

7. Crew behavior study shows consistency.

8. Although an attempt to correctly recover was initiated, the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery within the available remaining time before impact.

U.S. Comment:

The MCA subsequently proposed two additional hypothetical failure scenarios: a temporary spoiler wing cable jam and a temporary first officer control wheel jam. The MCA's draft final report properly concluded that the accident airplane's motion is defined by FDR- recorded control surface deflections, including spoiler and aileron (control wheel) deflections. The effects of a temporary spoiler wing cable jam or of a temporary first officer control wheel jam would render the previous statement (and the simulation data analyses upon which it is based) false. Therefore, considering these hypothetical failure scenarios is illogical.

Further, the MCA's draft final report did not explain how the airplane got to the point in the right roll at which the temporary jams supposedly occurred. Initially, the airplane was in a left bank, but it then started banking right. The MCA proposes that the fault occurred as the airplane was increasing through a bank angle of about 25°; however, the airplane's initial departure from the 20°-left-bank attitude occurred about 45 seconds before the hypothetical faults would have started. In addition, the first officer's comment, "turning right, sir," occurred about 9 seconds before the hypothetical faults would have started.

MCA Response:

3- Spoiler wing cable jam offset of the neutral position

Reference:

Item 6.3.5.3.1 (section 2.5.13) of the Report Scenario 10 - Spoiler wing cable jam offset of the neutral position at time 92450 (maximum wheel deflection).and clears at 92472, the following are the Results of the M-Cab test[3]

Assumptions:

- The spoiler wing cable is assumed to jam offset of the neutral position at time 2:44:36 (92450 time frames in seconds). At this time the ailerons and the aileron wheels were at their maximum deflections (based on the FDR data)
- The left aileron was at 8.1 degrees (Trailing Edge Down), the right aileron was at 11.8 degrees (Trailing Edge Up). The airplane pitch angle was 11.25 degrees. The roll angle was 24.6 degrees (right roll)
- This fault is assumed to be cleared at 2:44:58 (92472 time frames in seconds) (beginning of the recovery effort.

Consequences of the hypothetical failure:

- The ailerons control wheels will, when released (no load condition) move and remain at a position equal to the position at the moment of the jam (about 40 degrees right roll- FDR data) minus 12 degrees (transfer mechanism lost motion, caused by the effect of the feel and centering spring), resulting in about 28 degree wheel deflection in the right

[3] This test was done on Boeing M-Cab, Seattle, Washington

roll direction. This corresponds to about 7 degrees of aileron deflections. (considering ailerons offset).

- “The flight spoilers will remain in the position corresponding to the position of the jammed spoilers wing cables, irrespective of any mechanical inputs from either control wheel (about 12 degrees- FDR data).

- The ailerons can still be controlled via the captain's wheel. However, movement of aileron wheel towards airplane left turn (to correct for the right bank tendency) will be opposed by the override mechanism spring, consequently the forces required to move the ailerons in this direction will be significantly higher than the normal forces at no fault (about 50 lbs additional force)

- The F/O will not be able to control the ailerons in the direction of airplane left turn, with limited ability to control it in the direction of airplane right turn.

- This fault will not be associated with any visual indication or audio warning in the cockpit

Results of the M-Cab test (This test was done on Boeing M-Cab, Seattle, Washington):

The simulations take into account the effects of blowdown on the ailerons. However, the blowdown effects on the spoilers are not included because of the way in which these hypothetical faults were simulated.

The longitudinal plot includes the following parameters:

- Press Altitude (Feet)
- Airspeed (Knots)
- Right engine N1 (%)
- Longitudinal acceleration (g's)
- Air/ Ground switch
- Autopilot status
- Pitch attitude (Degrees)
- Body angle of attack (Degrees)
- Column deflection (Degrees)
- Elevator deflection (Degrees)
- Stabilizer position (Units)
- Normal load factor (g's)
- Right main gear down
- Flap detent (Degrees)

The lateral plot includes the following parameters:

- Press Altitude
- Airspeed (Knots)
- Right engine N1 (%)
- Roll attitude (Degrees)
- Wheel force (lbs)
- Control wheel deflection (Degrees)
- Left aileron deflection (Degrees)
- Right aileron deflection (Degrees)
- Left spoiler deflection (Degrees)
- Right spoiler deflection (Degrees)
- Lateral acceleration (g's)
- Magnetic heading (Degrees)
- Rudder deflection (Degrees)

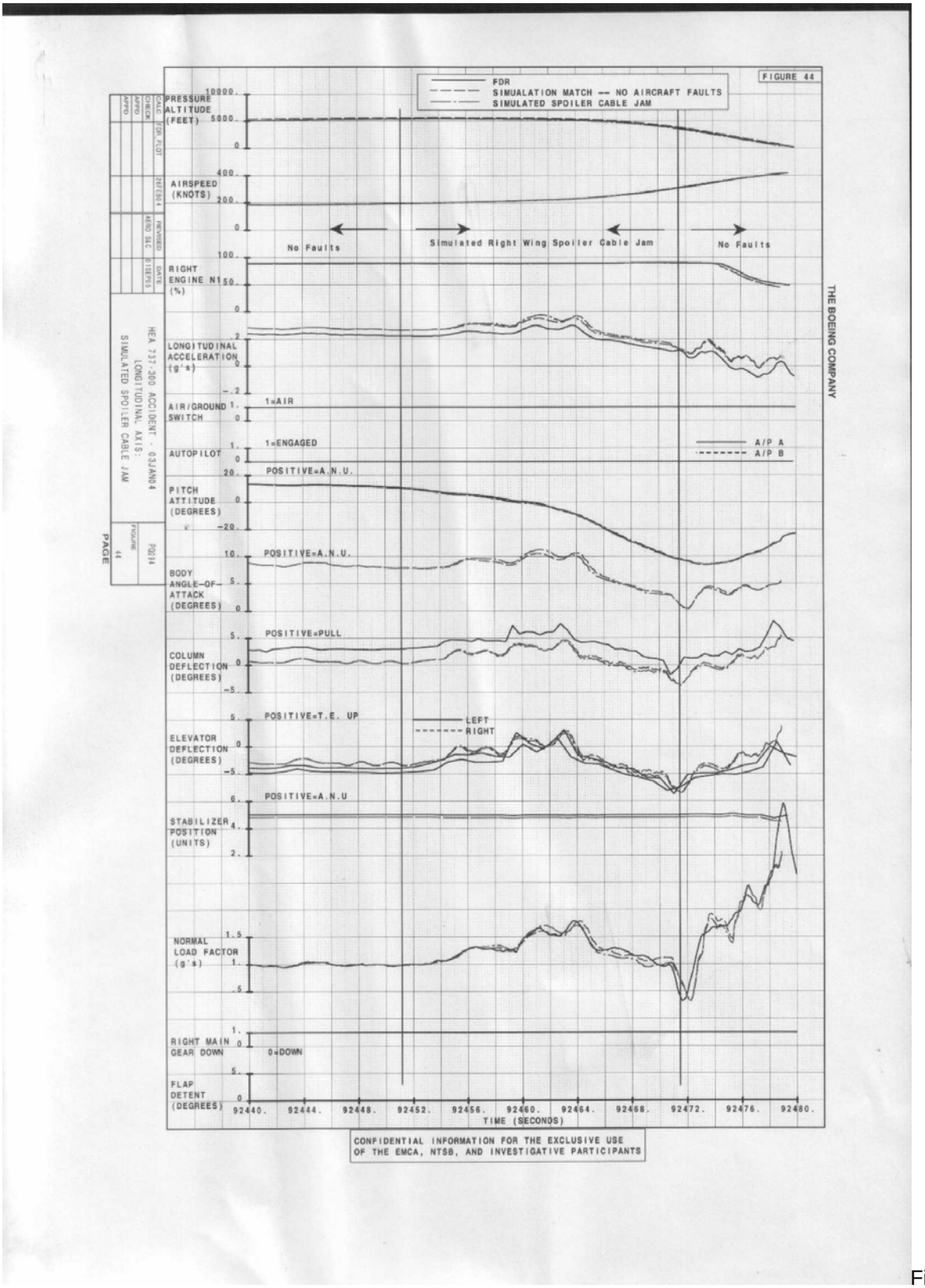


Figure 2.5.13.15a Scenario 10 - Spoiler wing cable jam (longitudinal parameters)

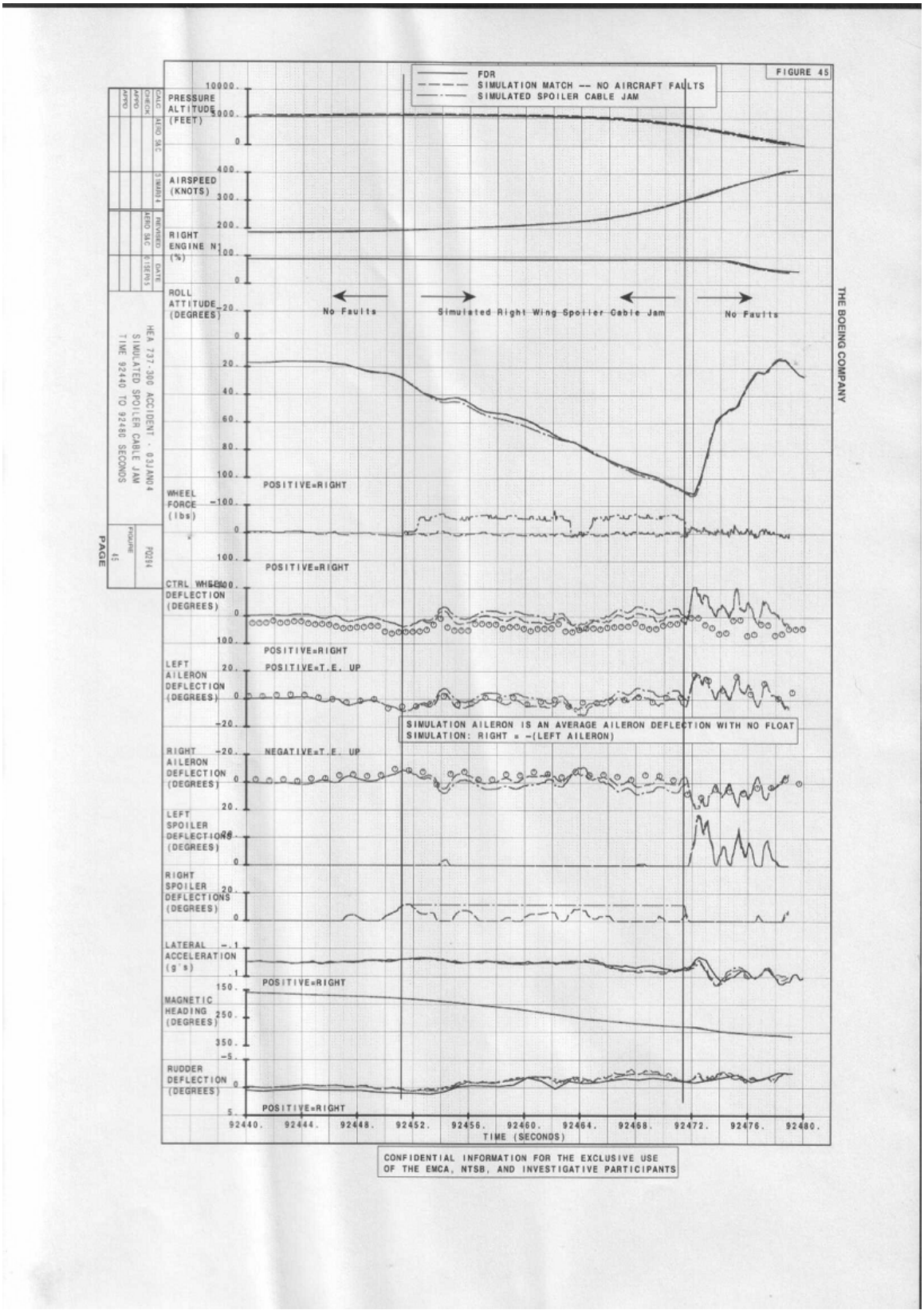


Figure 2.5.13.15b Scenario 10 - Spoiler wing cable jam (lateral parameters)

As shown from the two plots, the results obtained from the M-Cab test show a very close consistency with the FDR data which may explain this event. The estimated aileron wheel forces needed to move the wheel to correct for the right turn tendency is ~ 50 lbs.

In response to the comment *"The MCA's draft final report properly concluded that the accident airplane's motion is defined by FDR- recorded control surface deflections, including spoiler and aileron (control wheel) deflections. The effects of a temporary spoiler wing cable jam or of a temporary first officer control wheel jam would render the previous statement (and the simulation data analyses upon which it is based) false"*, the statement is incorrect due to the close consistency showed in above.

This fault could not be ruled out, based on the following:

- The results obtained from the analytical studies and the M-Cab test show a very close consistency with the available data.
- The airplane behavior is consistent with the consequences of the hypothetical fault:

1. The spoiler wing cable jams offset of the neutral position at time 2:44:36 (92450 time frames in seconds) and clears at 2:44:58 (92472 time frames in seconds, beginning of the recovery effort).
2. The ailerons movements towards airplane right roll are highly consistent with the expected position resulted from this hypothetical fault.
3. This fault always drive the airplane in the right roll direction
4. Movement of the aileron surfaces as shown in the FDR towards the neutral position are consistent with captain attempts to control the airplane attitude with the existence of the failure, the rate of airplane rolling to the right is always reduced with these attempts. The forces required to move the ailerons by the captain are considerably higher than the forces required in normal condition with no fault.
5. Whenever the captain control wheel is released, the ailerons move towards the offset position showing high consistency with the fault existence. The fault was continually driving the airplane towards more right roll
6. The movements of the ailerons throughout the last recovery phase highly support this scenario. The FDR data shows that even with the captain attempt to recover the airplane at the last stages.
7. In the analysis in section 2.5.11 studying the chronological event where the airplane stopped the left turn and started a right turn at about 92420, the pilot input probability was not ruled out as one of the possible causes for this event. The analysis in section 2.5.11 concluded that is not possible to determine a higher possibility to any of the mentioned possibilities based on the given data[4] including the pilot input.

[4] Refer to the Final Report Section 2.5.11 for full information

This explains how the airplane got to the point in the right roll at which the temporary jams supposedly occurred.

8. It is expected that wheel forces with higher magnitude can affect the speech pattern, however, it is noticed that there were no captain speeches when the ailerons were near to their neutral position, most of the speeches were made at the timing where the ailerons were moving back to their position relevant to spoilers cables jammed condition. The timing and length of the Captain speeches through this event does not provide sufficient information to verify the effect of this force on the speech tone

9. Crew behavior study shows consistency

10. Although an attempt to correctly recover was initiated, the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery within the available remaining time before impact.

4- Temporarily, First Officer wheel jam (offset of the neutral position) at time 92450 (maximum wheel deflection), and clears at 92472

Assumptions:

- The F/O wheel jam is assumed to jam offset of the neutral position at time 2:44:36 (92450 time frames in seconds). At this time the ailerons and the aileron wheels were at their maximum deflections (based on the FDR data)
- The left aileron was at 8.1 degrees (Trailing Edge Down), the right aileron was at 11.8 degrees (Trailing Edge Up). The airplane pitch angle was 11.25 degrees. The roll angle was 24.6 degrees (right roll)
- This fault is assumed to be cleared at 2:44:58 (92472 time frames in seconds) (beginning of the recovery effort.

Consequences of the hypothetical failure:

- The ailerons control wheels will, when released (no load condition) remain at a position equal to the position at the moment of the jam (about 40 degrees right roll-FDR data). This corresponds to about 10 degrees of aileron deflections (considering ailerons offset).
- The flight spoilers will remain in the position corresponding to the position of the jammed spoilers wing cables (about 12 degrees- FDR data), however the captain will have a limited control on the spoilers within the transfer mechanism lost motion gap (± 12 degree) of aileron wheel deflection.
- The ailerons can still be controlled via the captain's wheel. However, movement of aileron wheel in either directions will be opposed by the override mechanism spring, consequently the forces required to move the ailerons in both directions will be significantly higher than the normal forces at no fault (about 50 lbs additional force)

- The F/O will not be able to control the ailerons nor the spoilers in either direction.

- This fault will not be associated with any visual indication or audio warning in the cockpit

Results of the M-Cab test (This test was done on Boeing M-Cab, Seattle, Washington):

The simulations take into account the effects of blowdown on the ailerons. However, the blowdown effects on the spoilers are not included because of the way in which these hypothetical faults were simulated.

The longitudinal plot includes the following parameters:

- Press Altitude (Feet)
- Airspeed (Knots)
- Right engine N1 (%)
- Longitudinal acceleration (g's)
- Air/ Ground switch
- Autopilot status
- Pitch attitude (Degrees)
- Body angle of attack (Degrees)
- Column deflection (Degrees)
- Elevator deflection (Degrees)
- Stabilizer position (Units)
- Normal load factor (g's)
- Right main gear down

- Flap detent (Degrees)

The lateral plot includes the following parameters:

- Press Altitude
- Airspeed (Knots)
- Right engine N1 (%)
- Roll attitude (Degrees)
- Wheel force (lbs)
- Control wheel deflection (Degrees)
- Left aileron deflection (Degrees)
- Right aileron deflection (Degrees)
- Left spoiler deflection (Degrees)
- Right spoiler deflection (Degrees)
- Lateral acceleration (g’s)
- Magnetic heading (Degrees)
- Rudder deflection (Degrees)

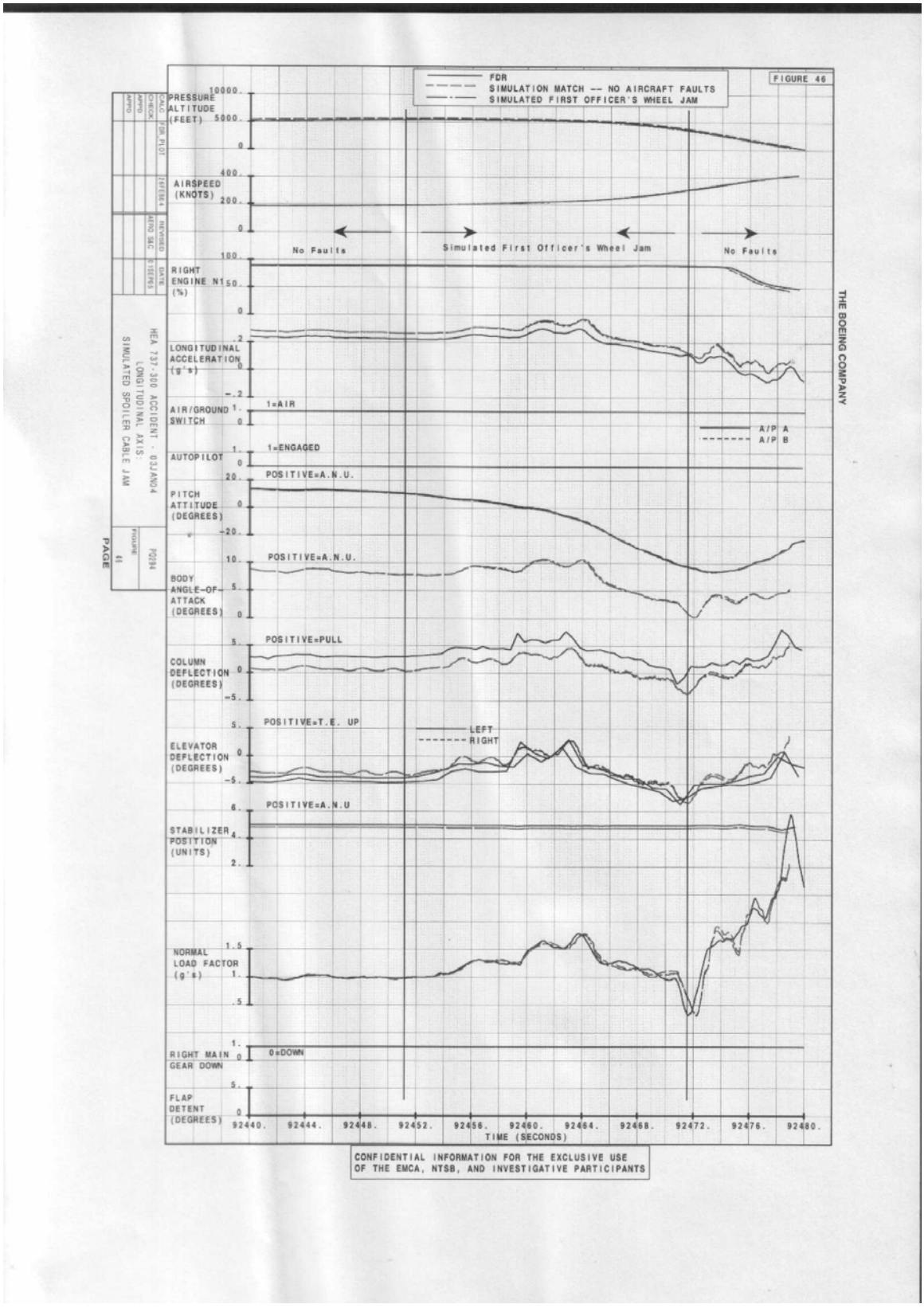


Figure 2.5.13.16a Scenario 10a - F/O wheel jam (longitudinal parameters)

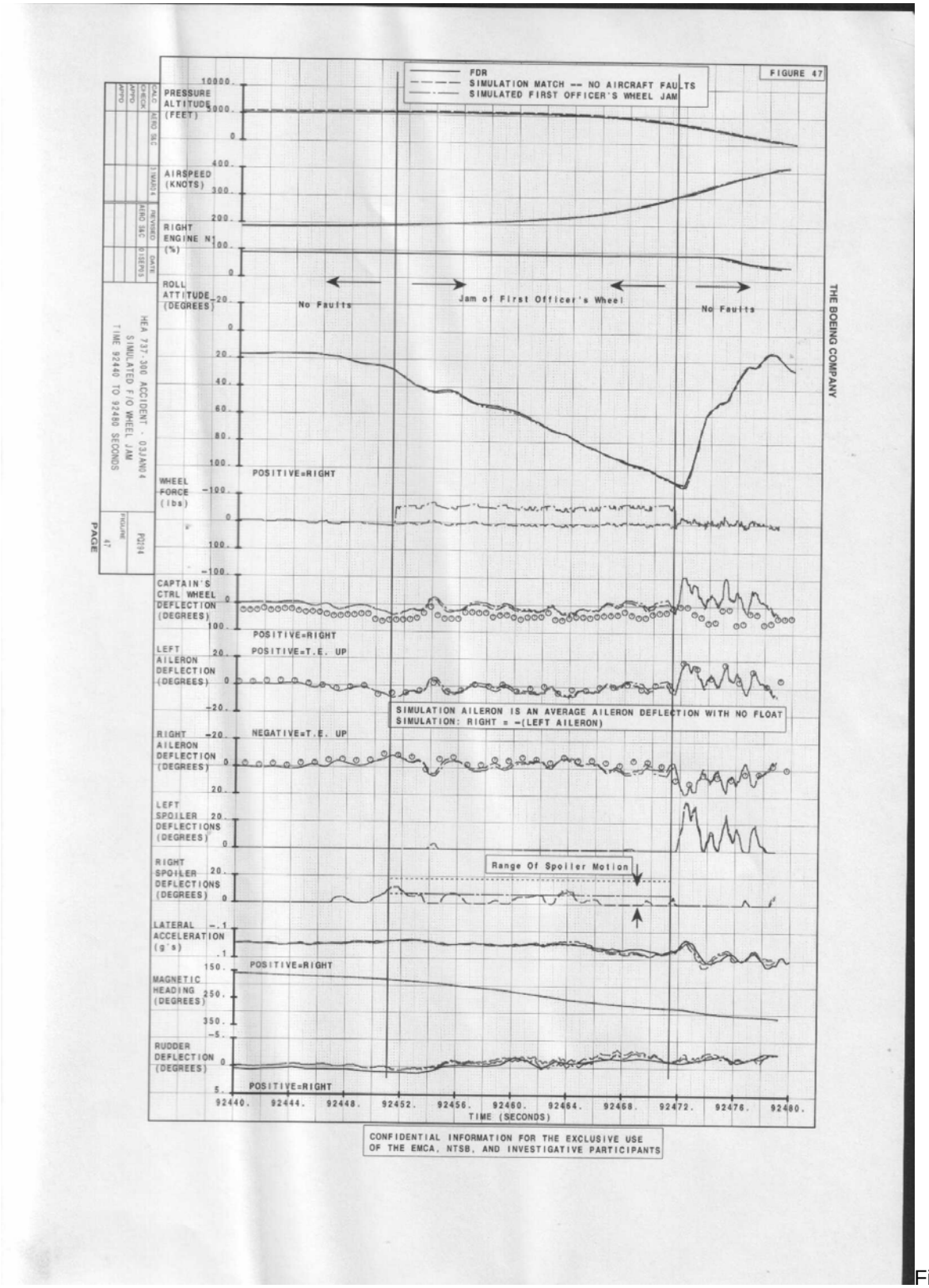


Figure 2.5.13.16b Scenario 10a - F/O wheel jam (lateral parameters)

As shown from the two plots, the results obtained from the M-Cab test show a very close consistency with the FDR data which may explain this event. The estimated aileron wheel forces needed to move the wheel to correct for the right turn tendency is ~ 50 lbs.

In response to the comment *"The MCA's draft final report properly concluded that the accident airplane's motion is defined by FDR- recorded control surface deflections, including spoiler and aileron (control wheel) deflections. The effects of a temporary spoiler wing cable jam or of a temporary first officer control wheel jam would render the previous statement (and the simulation data analyses upon which it is based) false"*, the statement is incorrect due to the close consistency showed in above..

This fault could not be ruled out, based on the following:

- The results obtained from the analytical studies and the M-Cab test show a very close consistency with the available data.

- The airplane behavior is consistent with the consequences of the hypothetical fault:

    1. The First Officer wheel jams offset of the neutral position at time 2:44:36 (92450 time frames in seconds) and clears at 2:44:58 (92472 time frames in seconds, beginning of the recovery effort).

    2. The ailerons movements towards airplane right roll are highly consistent with the expected position resulted from this hypothetical fault.

    3. This fault always drive the airplane in the right roll direction

    4. Movement of the aileron surfaces as shown in the FDR towards the neutral position are consistent with captain attempts to control the airplane attitude with the existence of the failure, the rate of airplane rolling to the right is always reduced with these attempts. The forces required to move the ailerons by the captain are considerably higher than the forces required in normal condition with no fault.

    5. Whenever the captain control wheel is released, the ailerons move towards the offset position showing high consistency with the fault existence. The fault was continually driving the airplane towards more right roll

    6. The movements of the ailerons throughout the last recovery phase highly support this scenario. The FDR data shows that even with the captain attempt to recover the airplane at the last stages.

    7. In the analysis in section 2.5.11 studying the chronological event where the airplane stopped the left turn and started a right turn at about 92420, the pilot input probability was not ruled out as one of the possible causes for this event.

        The analysis in section 2.5.11 concluded that is not possible to determine a higher possibility to any of the mentioned probabilities based on the given data[5]

[5] Refer to the Final Report Section 2.5.11 for full information

including the pilot input.

This explains how the airplane got to the point in the right roll at which the temporary jams supposedly occurred.

8. It is expected that wheel forces with higher magnitude can affect the speech pattern, however, it is noticed that there were no captain speeches when the ailerons were near to their neutral position, most of the speeches were made at the timing where the ailerons were moving back to their position relevant to spoilers cables jammed condition. The timing and length of the Captain speeches through this event does not provide sufficient information to verify the effect of this force on the speech tone

9. Crew behavior study shows consistency

10. Although an attempt to correctly recover was initiated, the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery within the available remaining time before impact.

Faults Contributing Factors:

The following contributing factors apply for the hypothetical faults:

- The faults were not associated with any visual indication or audio warning in the cockpit.
- The faults were not included in the FCOM (Flight Crew Operating Manual)
- The faults were not included in any training phase.
- There were no outside visual cues
- Although an attempt to correctly recover was initiated, the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery within the available remaining time before impact.

U.S. Comments:

2. The aileron inputs and corresponding right roll precipitating the upset resulted from flight crew inputs.

The MCA's draft final report correctly stated that FDR data and flight simulation analyses of the 737 showed that the lateral control inputs required to reproduce the airplane's recorded motion closely matched the aileron deflections recorded on the FDR. As discussed in the previous section, the data were not consistent with a jam or runaway of the aileron actuators or a spoiler or control wheel jam; rather, the data revealed that the ailerons remained active and available until the end of the recording. The airplane's left and right roll inputs, including the maximum right roll of 111 °, resulted from left and right wing aileron surface deflections during the time in which the autopilot was disengaged. The evidence indicates that the aileron inputs were commanded by the flight crew.

MCA Response:
With reference to the previous MCA analysis, it is clear that the referred to scenarios are still consistent with the FDR data.

MCA agrees with the U.S. comment *"the data revealed that the ailerons remained active and available until the end of the recording"*. However, with the existence of any of the technical faults scenarios included in the report, the pilot will need additional higher forces compared to the normal conditions at no failures to be able to control the ailerons, and that *"The airplane's left and right roll inputs, including the maximum right roll of 111 °, resulted from left and right wing aileron surface deflections during the time in which the autopilot was disengaged."* This statement supports the MCA conclusion regarding these scenarios.

MCA does not agree with the U.S. comment *"The evidence indicates that the aileron inputs were commanded by the flight crew"*. This is highly speculative and not the only possible indication of this action.

All the technical failures included in the Report (Conclusion section) result in aileron movement towards right airplane roll. Movement of the aileron surfaces as shown in the FDR towards the neutral position are consistent with captain attempts to control the airplane attitude with the existence of the failure.

U.S Comment:

3. The captain experienced spatial disorientation as the right roll inputs occurred.

Investigators sought to understand how a professional flight crewmember could have initiated and sustained the manual flight control inputs that resulted in the unintentional loss of the airplane. Available evidence suggests that the captain guided the airplane into an overbanked, airplane-nose-down attitude because he lost spatial orientation during the departure. Evidence consistent with factors that can contribute to spatial orientations were present before the crash. This evidence includes the following:

1. *dark night conditions,*
2. *misleading vestibular cues,*
3. *flight crew distraction, and*
4. *inappropriate control inputs.*

Dark night conditions. At the time of the accident, dark night, visual meteorological conditions prevailed. The only external visual references were lighted areas on the coast near Sharm EI-Sheikh. Soon\.after takeoff, the airplane passed over the coastline, and these external visual references were no longer visible to the flight crew.

Misleading vestibular cues. Studies performed by U.S. and French authorities, which were conducted at the MCA' s request, revealed that the vestibular sensations experienced by the flight crew would have been misleading throughout much of the flight. The flight crew's vestibular systems would have provided them with little or no information about the changes in the airplane's bank angle until after the right bank angle exceeded 30° because the gradual changes in the airplane's attitude would have been below the threshold of perception. As the airplane became fully involved in the right overbank and the angle of the bank continued to increase, the vestibular sensations of the bank angles would have underrepresented the actual bank angles, and the flight crew might even have felt brief vestibular sensations leading them to perceive that the airplane was banked slightly to the left. These findings indicate that, after the airplane passed over the coast and the external visual cues were lost, the captain could only have maintained an accurate awareness of flight attitude by continuously monitoring the attitude indications on his flight instruments.

Distraction. A few seconds before the captain called for the autopilot to be engaged, the airplane's pitch began increasing and airspeed began decreasing. These deviations continued during and after the autopilot engagement/disengagement sequence. The captain ultimately allowed the airspeed to decrease to 35 knots below his commanded target airspeed of 220 knots and the climb pitch to reach 22°, which is 10° more than the standard climb pitch of about 12°. During this time, the captain also allowed the airplane to enter a gradually steepening right bank, which was inconsistent with the flight crew's departure clearance to perform a climbing left turn. These pitch, airspeed, and bank angle deviations indicated that the captain directed his attention away from monitoring the attitude indications during and after the autopilot disengagement process. .

Changes in the auto flight system's mode status offer the best explanation for the captain's distraction. The following changes occurred in the auto flight system's mode status shortly before the initiation of the

right roll: (1) manual engagement of the autopilot, (2) automatic transition of roll guidance from heading select to 9 control wheel steering-roll (CWS-R), (3) manual disengagement of the autopilot, and (4) manual reengagement of heading select for roll guidance.
The transition to the CWS-R "mode occurred in accordance with nominal system operation because the captain was not closely following the flight director guidance at the time of the autopilot engagement. The captain might not have expected the transition, and he might not have understood why it occurred. The captain was probably referring to the mode change from command mode to CWS-R when he stated, "see what the aircraft did?," shortly after it occurred. The available evidence indicates that the unexpected mode change and the flight crew's subsequent focus of attention on reestablishing roll guidance for the auto flight system were the most likely reasons for the captain's distraction from monitoring the attitude indications.

According to CVR information, 24 seconds elapsed after the airplane entered the right bank before either flight crewmember acknowledged or attempted to correct the steepening right bank. However, as the airplane-was rolling from 16° to 40° right bank, the first officer stated, "turning right sir," and the captain replied, "what?" The first officer repeated, "aircraft is turning right," and the captain asked, "ah...turning right...How turning right?" The surprise evident in the captain's responses to the first officer's announcements about the airplane's attitude indicate that he was distracted from monitoring the attitude indications for at least 24 seconds after entering the right bank.

Inappropriate control inputs. The control wheel inputs made by the captain after the first officer told him about the right turn indicate that the captain had become spatially disoriented and that he had experienced some delay in reacquiring an accurate sense of his (and the airplane's) orientation with respect to the Earth's surface.

An appropriate response to the first officer's advisories about the right turn would have been for the captain to direct his attention to the attitude indications, confirm the airplane's attitude, and apply sufficient left control wheel force to stop the right roll and sustain a roll back toward the left. However, such corrective inputs did not begin until 17 seconds after the flight crew's exchange about the right turn. Instead, the captain made inappropriate, oscillating control wheel inputs, with rightward control wheel inputs being dominant, which caused the airplane to roll to a right bank angle of 111° and a pitch attitude of 46° airplane nose down.
The persistent inappropriate nature of the captain's right control wheel inputs suggest that he was unable to immediately regain an accurate awareness of spatial orientation. Studies indicate that pilots may require some time to recover from an unknown attitude and transition to stable instrument flight after a lengthy period of distraction from flight instruments. Investigations of roll upset accidents and incidents involving commercial airline flights have also revealed that from 4 to 18 seconds may elapse between the time that a pilot becomes aware of a problem with airplane attitude and the time that sustained, appropriate control wheel inputs begin.

MCA Response:
With reference to section 2.6. Crew Behavior, Report, the study performed by a team of qualified Human Performance Specialists has come up with findings summerized as follows:

- An event starting from the time of call for autopilot engagement through the time of the captain statement “see what the aircraft did” caused obvious crew distraction. This distraction may have developed to Spatial Disorientation (SD) to the captain until the time the F/O announced “A/C turning right “ and acknowledged by the captain.

- There are conflicting signals in the following period of time (~ 17 seconds), it is unclear whether the captain remained in SD or was the crew unable to perceive the cause that was creating an upset condition until the time when the F/O announced that there was no A/P in action.

- After the time when the F/O announced “no A/P commander” the crew behavior suggests that recovery attempts were consistent with expected crew reaction, evidences show that the the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery.

U.S Comment:

4. The first officer did not assume timely control of the airplane.

The first officer's lack of assertiveness during the accident sequence indicated that he had inadequate CRM skills. The first officer's verbal communications indicated that he had an accurate awareness of the airplane's flight attitude during the upset sequence. However, he did not escalate his assertiveness to prevent the captain from overbanking the airplane to the right. The first officer could have offered suggestions, issued commands, or attempted to take control of the airplane. Instead, as the airplane's bank angle exceeded 40°, the first officer began repeatedly calling out, "overbank," and issuing routine responses to the captain's requests for autopilot engagement.

MCA Response:
MCA does not agree with the U.S. comment. All evidences extracted from the FDR and CVR do not support this statement. On the contrary, the first officer's verbal communications indicated that he had an accurate awareness of the airplane's flight attitude during the upset sequence. MCA analysis of the crew behavior (F/O and Observer) indicate that actions taken in the cockpit did not call for any additional intervention supporting the view that the PF was counteracting some unusual condition..

U.S Comment:

Differences in flight crewmember status. Disparities between the captain's and first officer's aviation experience likely produced differences in perceived status between the two men, which might have reduced the first officer's willingness to escalate his assertiveness to the point of taking control of the airplane. The 53-year-old captain had been a pilot for over 35 years, held an airline transport pilot certificate, and had accumulated about 7,400 flight hours. He had retired from the Egyptian Air Force in 2000 with the rank of Air Vice Marshal (equivalent to a U.S. brigadier general). He had served as a pilot and flight instructor in high-performance military jets, and he had flown as pilot-in-command on four different types of transport-category airplanes. The 25-year-old first officer had been a pilot for 7 years, held a commercial pilot certificate, and had accumulated about 800 flight hours. The first officer had no prior experience with transport-category airplanes before joining Flash Airlines.

MCA Response:
MCA does not agree with the above U.S. comment. Based on the factual information regarding both the cockpit crew members included in "Chapter 1 (Factual Information), Sections 1.5.1 and 1.5.2, Final Report", both cockpit crew members were satisfying all the regulatory requirements. In addition, it is quite normal to have a captain that is older than the first officer with higher flying experience and in this case a positive response of the F/O indicating airplane turning right and overbank clearly shows that he was not negatively influenced by authority gradient. Also the observer pilot (43 years old, 4000 flying hours, U.S. license holder) reaction also supports that actions in the cockpit did not require any intervention with the PF

U.S. Comment:

Flash Airlines CRM training. Many previous accidents have occurred when captains' errors went unchallenged by first officers. Aviation studies have provided further evidence about the role of poor CRM in accidents and about the importance of emphasizing CRM skills in airline training. Guidelines for CRM training encourage carriers to train their pilots how to promote a course of action they feel is best, even if it involves conflict with others. This is a difficult issue for many carriers, because encouraging flight crewmembers to challenge a captain's authority could increase disagreements between flight crewmembers, potentially creating a new set of safety concerns. However, the accident record suggests that safety benefits may be obtained by encouraging first officers to be appropriately assertive if a captain does not appropriately address an imminent threat to flight safety.

Flash Airlines' training manual contained a CRM ground training course outline marked,

effective January 2, 2003." The manual stated that CRM training would be provided to pilots during initial and recurrent training and would consist of 12 hours of instruction over 2 days. One of the topics included in this training was "communication skills of inquiry, advocacy, and feedback." The airline's Flight Operations Manual stated, "During flying training on aeroplanes with a flight crew of 2 particular emphasis will be placed on the practice of Line Orientated Flying Training (LOFT) with emphasis on Crew Resource Management (CRM) and the use of correct crew coordinated procedures." Despite the existence of these documents and policies, the MCA's report stated that Flash Airlines did not provide CRM training to either of the accident pilots. Therefore, the first officer did not receive training in skills that could have helped him playa more active role in the airplane's recovery.

MCA Response:

It is to be noted that the CRM training was not mandatory at the time of the accident. MCA believes that, although a level of CRM was observed, it is clear that more emphasis in this area of training will achieve earlier recognition and recovery from abnormal conditions

U.S Comment:

5. The airplane remained fully controllable and responsive to the flight controls throughout the flight.

Analysis of the FDR data revealed that the airplane remained controllable throughout the entire flight. The maximum recorded bank and pitch angles during the airplane's descent were about 111° right wing down and 46° airplane nose down, respectively. As a result of flight crew corrective roll and pitch inputs, the airplane began to recover; however, the recovery attempt began too late to prevent the accident. FDR data indicated that, just before impact, the bank and pitch angles had decreased to about 14° right wing down and 23°oirplane nose down, respectively.

MCA Response:

MCA agrees with the U.S. remark that the analysis of the FDR data revealed that the airplane remained controllable, on condition that any failure condition was correctly perceived and timely correction applied.

U.S. Comment:

CONCLUSIONS

In summary, the evidence collected during this c investigation strongly supports the conclusions that no airplane-related malfunction or failure caused or contributed to the accident and that the accident can be explained by the captain's spatial disorientation and the first officer's failure to assume timely control of the airplane.

MCA response:

An event starting from the time of call for autopilot engagement through the time of the captain statement “see what the aircraft did” caused obvious crew distraction. This distraction may have developed to Spatial Disorientation (SD) to the captain until the time the F/O announced “A/C turning right “and acknowledged by the captain.
There are conflicting signals in the following period of time (~ 17 seconds), it is unclear whether the captain remained in SD or was the crew unable to perceive the cause that was creating an upset condition until the time when the F/O announced that there was no A/P in action.
After the time when the F/O announced “no A/P commander” the crew behavior suggests that recovery attempts were consistent with expected crew reaction, evidences show that the the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery.

MCA believes that the, with reference to section 3 Conclusion of the report, the possible accident causes are as follows:

- Trim/ Feel Unit Fault (Aileron Trim Runaway)
- Temporarily, Spoiler wing cable jam (Spoiler offset of the neutral position)
- Temporarily, F/O wheel jam (spoilers offset of the neutral position)
- Autopilot Actuator Hardover Fault

Possible contributing factors are as follows:

- A distraction developing to Spatial Disorientation (SD) until the time the F/O announced “A/C turning right” with acknowledgement of the captain.
- There are conflicting signals which make unclear whether the captain remained in SD or was the crew unable to perceive the cause that was creating an upset condition until the time when the F/O announced that there was no A/P in action.
- After the time when the F/O announced “no A/P commander” the crew behavior suggests the recovery attempt was consistent with expected crew reaction, evidences show that the corrective action was initiated in full, however the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery.

U.S. Detailed Comments on Draft Final Report of Aircraft Accident
Flash Airlines flight 604, Boeing 737-300, SU-ZCF
January 3, 2004, Red Sea near Sharm El-Sheikh, Egypt

FACTUAL[6]

U.S. Comment:

Page 24, Section 1.5.1.2., Background information, ii

The third bullet point notes the captain's work experience at Scorpio Aviation.

This section and elsewhere, as appropriate, should address the apparent shortcomings with the captain's ATR 42 training and/or records (the captain did not meet ATR training minimums recommended by the airplane manufacturer, and the draft final report does not establish how these compared to ECAA minimum requirements). It also appears that some of the captain's ATR flight training was performed during passenger flights.

Page 24, Section 1.5.1.2., Background information, ii
The fourth bullet point should correct the accident date to be 3 January 2004.

MCA Response

Corrected

U.S. Comment:

Page 24, Section 1.5.1.2., Background information, v

Section v currently reads:

> History of position flown for specific aircraft, and dates of upgrades (i.e., copilot to captain)
> Refer to page 14 of the Factual Report

Information on the captain's positions flown (i.e., flight engineer, first officer, captain) for specific airplanes and dates of his position upgrades (in the military and in civil aviation) should be inserted or referenced here. This information is not contained on p. 14.

Page 24, Section 1.5.1.2., Background information, vi

[6] U.S. comments are shown in yellow background

Section vi is currently titled:

"All" captain's training records (including his last recurrent training).

Records documenting the captain's hours of Boeing 737 ground training and Flash Airlines company indoctrination training should be included in the pages of training records that follow page 24. Such records were included for the first officer. If such records are unavailable for the captain, this should be explained.

MCA Response:

Added

U.S. Comment:

Page 61, Section 1.5.1.7., Additional factual documentation (Captain)

A note at the bottom of the page states that the captain took a deadhead flight from CAI to SSH on January 1, 2004.

This section should list other deadheading flights by the captain during the period covered by the table.

MCA Response:

Adopted

U.S. Comment:

Page 63, Section 1.5.1.7., Additional factual documentation (Captain)

The first paragraph on this page states:

> The captain's time on Russian aircraft (MiG-21). Hercules transport aircrafts C130 (dates and number of hours). ADI display configuration in comparison with B737-300 ADI display. Refer to captain CV, and item 1.5.1.2 (vi)

Neither the captain's C.V. nor his training records contain this information.

The captain's flight experience on MiG-21 and C-130 airplanes and a comparison of their attitude displays with the displays of the accident airplane should be provided here.

MCA Response:

Captain flew approximately in this sequence:
Russian Mig: 1000 flying hours (Russian ADI display)
C130: 5000 hours (Conventional ADI display)
ATR: 700 hours (Conventional ADI display)
Boeing 737: 700 hours (Conventional ADI display)

U.S. Comment:

Page 65, Section 1.5.2.2., Background information

Section i of this page, titled "Beginning of his flying career" summarizes the first officer's Boeing 737-300 initial training. It states:

- The F/0 began his ground training on the aircraft type 737-300 at Luxor Airway from 4 May 2002 to 16 May 2002
- The F/0 completed the Full Flight Simulator Training and the Flight Training at Flash Airline on 30 June 02

Section 1.17.2.1, page 312, states that a January 2003 ECAA audit found Flash Airlines

had no training program. Information should be provided here describing the training program used for the first officer's May 2002 Boeing 737 ground training.

The first officer's initial simulator proficiency check form, dated June 30, 2002 states that a Boeing 737-300/400/500 simulator was used. Information should be provided about which variant the simulator was configured to represent, and whether the first officer received any differences training for the 300/400/500 variants.

MCA Response:
Note: (added)
Luxor Air training forms are approved training syllabus by ECAA. The audit of Flash Airline carried on January 2003 comment that Flash was still using training forms under the name of the previous operator who was also ECAA approved but they should change the forms to the name of Flash.

U.S. Comment:

Page 76, Section 1.5.2.2., Background information

This page contains a copy of the first officer's training record titled "Proficiency Check Form," dated July 02. A notation on the document says it is page 1 of 2, but the second page is not included. It states that it is from the flight training department of Heliopolis

Airlines, and that the first officer's proficiency check was conducted in a Flash Airlines airplane. MCA has added a notation to the bottom of the page stating that Flash Airlines took over some of the Heliopolis Airlines routes, but this does not explain the use of Heliopolis training forms.

Information should be provided about whether Flash Airlines was utilizing the training program of Heliopolis Airlines and whether the use of Heliopolis training forms by Flash Airlines was acceptable under ECAA regulations.

MCA Response:

Added

U.S. Comment:

Page 97, Section 1.5.2.3., 72-hour history of the F/0

This section refers the reader to pages 72 and 73 of the factual report for information on the F/0's 72-hour history. Neither pages 72 and 73 of the factual report, nor pages 72 and 73 of the draft final report provide a narrative description of the first officer's activities in the 72 hours before the accident.

The first officer's work schedule and any other known activities in the 72 hours before the accident should be summarized here in a narrative format.

Page 107, Section 1.6.2.1 Electronic Attitude Direction Indicator (EADI)

Some of the original text for the description of the EADI is missing. The original text stated:

> The artificial horizon line which separates the upper blue portion of the display from the lower brown portion moves up and down as the airplane pitches and tilts.

The sentence should read:

> The artificial horizon line which separates the upper blue portion of the display from the lower brown portion moves up and down as the airplane pitches and tilts left and right as the airplane rolls.

MCA Response:

Adopted

U.S. Comment:

Page 120, Section 1.6.6.3, section C

This section states:

> On January 3rd, 2003, aircraft SU-ZCF, a daily check was performed in accordance with the approved checklist as per the company maintenance

schedule at SSH station just before the flight. The check was carried out by the accident flight on board engineer.

Date should be changed to 3 January 2004, not 2003. The report should clarify how it is known that this check was completed, as the maintenance records were reportedly lost with the aircraft.

MCA Response:

Adopted

U.S. Comment:

Page 121, Section 1.6.6.4, The maintenance log sheets for the flights after 12/31/03

This section states:

> Lost on board and no copies prior to departures from SHH which is a violation of ECAA regulations. Necessary measures are taken by ECAA to ensure adherence.

The specific ECAA regulations that apply should be provided here, as well as the steps taken by ECAA to ensure adherence.

U.S. Comment:

Page 121, Section 1.6.6.5, The lack of write-ups on the TOGA problem and slat indication that existed on the entire 25-hours of FDR

This section states:

> Status of the technical log is not known due to being lost on board

The Flash Air chief pilot stated during the investigation that the airline was aware of the problem and had established a work-around procedure. The report should note this here and discuss why the TOGA problem was not addressed.

MCA Response:

Note:

The pages lost on board covers 25 hours

U.S. Comment:

Page 133, Section 1.10, Aerodrome Information

This section states, in part:

> Clearance was provided to the accident flight crew while on the ground and the departure included a left turn at pilot's discretion and to climb to Flight Level (FL) 140 and to intercept the 306 VOR radial. MEA for this sector is 10500 ft.

The report should clarify the existence of various published minimum altitudes in the area of SSH. The report does not include any enroute charts showing Minimum Enroute Altitudes (MEA) in the vicinity of SSH. Commercially available charts for the area indicate that the MEA along the A411 airway, which is defined by the 306 radial of the SSH VOR is 12,000 feet. The SSH minimum radar vectoring altitude chart on p. 126 of the report (Section 1.8.1) indicates that a minimum radar vectoring altitude of 10,500 DME begins many miles to the northwest of the VOR.

U.S. Comment:

Page 142, Section 1.13.1, Egyptian Air Force - Medical Board Report

This section states, in part:

1. Sequence of medical records

a) Medically fit for all flying duties as from his first medical examination dated 30/05/1970.

b) Amend to be medically fit for all flying duties to be reexamined every sis months as of 14/07/1982.

c) Amend to be medically fit for all flying duties (remove six months restriction) as of 22/04/1985.

The report should explain the reason for the amendment that required the captain to be medically re-examined every six months from July 1982 until April 1985.

U.S. Comment:

Page 142, Section 1.13.1, Egyptian Air Force - Medical Board Report

This section states, in part:

> During Service A.F. Pilots are subjected to the following:
> a) Tests for Spatial Disorientation as part of his routine periodic physical examination.
> b) Sessions of physiologic training which include:
> - Sudden Decompression.
> - Certificate.
> - Spatial Disorientation Training Chair.

A detailed description of the purpose and nature of the captain's prior spatial disorientation tests and training, referenced here, should be added to the report.

U.S. Comment:

Page 146, Section 1.13.2. Medical factors related to SD (Spatial Disorientation)

Section C of this page states:

> C- Medical records for the captain related to any of the conditions conducive to spatial disorientation.
> No report found

A description of the types of medical conditions conducive to spatial disorientation that were considered during this search should be inserted here.

MCA Response:

No conditions inducive of spatial disorientation recorded

U.S. Comment:

Page 153, Section 1.16.1, Section F

The spoiler control drum jam and control wheel shaft jam scenarios were not evaluated in the MCAB. These cases were accomplished by "background" simulation analysis.

MCA Response:

Adopted

U.S. Comment:

Pages 177-204, 214-218, 221-222, 227-235, 237-242, 247, 249-250, 252, 254-263, and 265

These pages contain references to Boeing proprietary information that cannot be released.

Boeing has no objection to the release of information contained on these pages of the draft final report.

MCA Response:

Adopted

U.S. Comment:

Pages 187 -188, Section 1.16.1.2. FDR data plots (presented by Boeing)

The data in this section should use the latest revision provided to the MCA, dated 21 Sept 04.

MCA Response:

Adopted

U.S. Comment:

Page 247, section 1.16.1.9. Flash Airlines AI236 RAM Simulator Configuration
(Flash Airlines AI236RAM Simulator Configuration.htm, Program_Pins.pdf)

"Boeing proprietary information and will not be available for public use"

The file referred to on this page is the request made to Royal Air Maroc (RAM) by Boeing on behalf of the MCA. The answer from RAM that defines the simulator configuration was provided to the MCA on 1 August 2005 and should be summarized here.

MCA Response:

Adopted

U.S. Comment:

Page 266, Section 1.16.1.10. Boeing response to raised questions.doc
"Flash Airlines Autopilot Answer to Questions - 31 Jan 2005.ppt

Boeing proprietary information and will not be available for public use"

Boeing was unable to locate a file by this name.

MCA Response

The unidentified file had been mailed to Boeing

U.S. Comment:

Page 267, Section 1.16.1.10. Boeing response to raised questions.doc
"Answers to questionnaire meeting05.ppt Boeing/ Honeywell

Boeing/ Honeywell proprietary information and will not be available for public use"

Boeing and Honeywell were unable to locate a file by this name.

MCA Response:

The unidentified file had been mailed to Boeing

U.S. Comment:

Pages 270-281,1.16.2., Tests and researches conducted by NTSB

This section contains PowerPoint slides from a presentation prepared for the MCA by an NTSB investigator.

The name of the NTSB investigator should be removed from the report, and the Powerpoint slides should be replaced with a brief description of the method used for this study and a description of its findings.

MCA Response:

Adopted

U.S. Comment:

Pages 283-303, Section 1.16.4., Tests and researches conducted by MCA

This section contains general information on spatial disorientation that appears to have been copied verbatim from a U.S. Army Field Manual, FM 3-04.301, Aeromedical Training for Flight Personnel.

Suggest that the original source for this material be identified and cited in the report. Suggest that relevant information from this source be summarized in a brief format, rather than including the entire document.

MCA Response:

Adopted

U.S. Comment:

Page 304, Section 1.16.4., Tests and researches conducted by MCA

Any information contained in the various documents cited on this page that the MCA believes is of particular relevance to this accident should be summarized in a narrative format.

U.S. Comment:

Page 312, Section 1.17.2.1 Safety oversight carried out on Flash Airline during the period from 2 Jan, 2003 to 16 Jan 2003 before AOC renewal

The table on this page labeled "Operation Findings" states:

> Findings: There is no Training Program
> Actions Taken: Training Program is submitted and approved

The report should explain how the airline had originally received its AOC when it had no training program.

MCA Response:

Refer to previous note about Flash Airline previous operator

U.S. Comment:

Page 312, Section 1.17.2.1 Safety oversight carried out on Flash Airline during the period from 2 Jan, 2003 to 16 Jan 2003 before AOC renewal

The table on this page labeled "Operation Findings" states:

> Findings: There are no DRM &CRM Training course performed for cockpit crews, dispatchers and cabin crews
> Actions Taken: The Airline has introduced a training plan starting on Sep 2003 to be done in PAS Airline

It is suggested that this section include some explanation as to why the accident pilots did not receive this training.

U.S. Comment:

Page 312, Section 1.17.2.1 Safety oversight carried out on Flash Airline during the period from 2 Jan, 2003 to 16 Jan 2003 before AOC renewal

The table on this page labeled "Operation Findings" states:

> Findings: By reviewing the A/C log book sheets found that, some sheets not filled out and other some have missed data
> Actions Taken: The airline issued circular for all cockpit crews and maintenance staff to strictly comply with log book sheets filling out instructions

Because of other similar findings during the accident investigation, it is suggested that

further detail about the circular and any additional action by the airline or the ECAA be provided.

U.S. Comment:

Page 313, Section 1.17.3.1, Flash Airlines procedures regarding use of autopilot when recovering from unusual attitudes

This section states:

> Refer to Flash Airline FOM (Ops Group)

Relevant information from the Flash Airlines FOM should be summarized and included in this section.

U.S. Comment:

Pages 320-323, Section 1.17.3.8 Egyptian requirements for the training of pilots at an airline such as Flash Airlines

This section contains excerpts from the Egyptian Ministry of Civil Aviation Training Standards Handbook.

Information relevant to the flight crew and the type of operation involved in the accident should be extracted from these materials and summarized in the report.

The report should also state whether the captain met the ECAR airplane group experience requirements of 2500 hours on turbo-jet powered aircraft > 5,700 kg (as stipulated in the report on p. 323) prior to being initially certified as PIC for Part 121 Air Taxi flights utilizing Group IILJ aircraft. Information contained in the draft final report indicates that the captain may have only acquired 1,009 hours of jet experience (on L-29, Mig 17, and Mig 21 airplanes) by the time he was hired by Flash Airlines.

U.S. Comment:

Page 326, Section 1.17.3.11 Flash Airlines program for training and checking pilots in the field of CRM and human factors (as contained in the company training manual)

This section states:

> No mandatory training was required by ECAR at the time of the accident. However, CRM course is outlined in Flash Airline Training Manual 4.10

Suggest that the report explain whether the presence of an approved training module in the carrier's training manual meant that the company was obligated to provide the training to its pilots. Also suggest that the report explain why the ECAA's January 2003 audit of Flash Airlines would cite a lack of CRM training at Flash Airlines as an operational shortcoming when such training was not required in Egypt.

U.S. Comment:

Page 326, Section 1.17.3.12 Flash Airlines pilots procedures for training and checking pilots on spatial disorientation countermeasures and upset recovery

This section states:

> Spatial Disorientation training is not a requirement by Civil Aviation Authorities. However, some literature about this subject is included in Flash Airline Training Manual.

Relevant material contained in the Flash Airlines Manuals should be referenced, summarized, and inserted in this section.

U.S. Comment:

Page 327, Section 1.17.3.20 Previous violations, fines, or bans levied foreign aviation regulatory agencies

This section states:

> None identified.

Information should be added to the report acknowledging the Flash Airlines violations documented by the Swiss government. In particular, the following details are known and should be added to the final report.

The Swiss FOCA conducted two Safety Assessment of Foreign Aircraft (SAFA) ramp inspections on Flash Airlines B-737 aircraft in 2002. Aircraft SU-ZCD was inspected on April 27, 2002, and SU-ZCF (the accident aircraft) was inspected on October 11, 2002. Egyptian authorities were informed by FOCA in writing of the results of both inspections. The inspections revealed numerous and significant safety-related deficiencies. According to FOCA, a ban was issued on further Flash Airlines flights to Switzerland effective October 17, 2002, because of the similarities of the inspection findings on the two aircraft and the lack of appropriate response by the airline to the safety issues.

MCA Response:

Reviewing this report indicated that the ban was due to a conflict on financial issues and no relevant safety issues were mentioned.

U.S. Comment:

Page 327-333, Section 1.17.3.22 Airline Simulator program contract with RAM, ECAA letter of approval

This section contains several pages concerning approval of a Royal Air Maroc Boeing 737-500 simulator for use by EgyptAir, dated September 2003.

The report should clarify how this approval applied to Flash Airlines' training program and address the basis for the captain's apparent training on the simulator in April/May 2003 before the September 2003 approval of the simulator.

U.S. Comment:

Page 334, Section 1.17.3.23 Simulator used by Flash Airlines at RAM

The statement "pending Boeing response" should be deleted. The MCA asked Boeing for help in determining what differences existed between the RAM simulator used for the Flash Airlines training and the accident aircraft. Boeing forwarded a request for information to RAM and relayed their answer to the MCA on 1 Aug 2005.

MCA Response:
Adopted

This section should also include information about differences in the functioning of the Royal Air Maroc simulator and the accident airplane, such as differences in the sensitivity to direction of turn on the MCP heading knob.

U.S. Comment:

Page 334, Section 1.17.3.24 Flash Airlines procedures regarding which pilot (PF or PNF) engages the autopilot, Boeing recommended practice

This section states:

> No written procedure was found in Flash Airline FOM regarding this issue. Boeing procedures and common practices are for PF to connect the autopilot.

This section should note the Flash Air chief pilot's statements that it was company policy for the PNF to engage the autopilot, and information should be provided to explain why the procedure is contrary to Boeing procedures. This section should also note that the page of the Flash Airlines Flight Operations Manual dealing with this subject was missing.

U.S. Comment:

Page 335, Section 1.17.3.25 Additional information regarding dispatch from SSH

This section states:

> B- Extension of the outbound legs before beginning the turn
>
> Interviewing Flash Airlines chief pilot: Flash Airlines chief pilot stated that during the departure from SSH, Flash Airline pilots might extend the circuit as the situations need whether day or night departures (departure over water is mandatory)
>
> Actual pattern flown depends on airplane performance (weight, OAT, etc). Most airplanes widen the pattern to gain additional altitude as a pilot technique. VOR crossing altitude restriction is shown on charts. This information should be added to Operations Group Notes.

It is suggested that the report identify the crossing altitude and the charts that display the altitude crossing restriction for the SHM VOR that is referenced here.

The report should also note conflicting evidence on the prescribed crossing altitude. The Director of Radar Airports, National Air Navigation Service Company, told investigators that the minimum SHM VOR crossing altitude for ATC purposes was 4,000 feet, but pilots prefer to cross it above 10,000 feet. FDR data from previous flights of the accident airplane showed a departure from SSH requiring a turn to cross back over the VOR where no widening of the turn was evident, and the VOR was crossed below 7,000 feet MSL.

U.S. Comment:

The section on this page titled, "Meeting with Captain Khedr's wife 24/10/2004" states, in part:

> In the year 1999 he was awarded a prize when he landed in a difficult weather in Sarayevo.

Suggest that this information be clarified. It appears to conflict with the footnote on Page 142, Section 1.13.1, Egyptian Air Force - Medical Board Report, which states:

> During the time from 1997 to 1999 the Captain held an administnve [sic] post (Chief of Staff of an Air force base) with no flying duties.

MCA Response:

Corrected

U.S. Comment:

Page 354, Section 7.3 Last PDC Carried out for the Accident Flight
See comments provided for p. 120, Section 1.6.6.3

U.S. Comment:
Page 356:

This table of information should be titled, since it is unclear what it refers to.

MCA Response:

Adopted

U.S. Comment:

Page 621, Exhibit C, Cockpit Voice Recorder (CVR), Group Factual Report

The "tsk tsk" vocalization attributed to the first officer (just before his statement "Overbank overbank overbank" that began at 02:44:48) should be added to the transcript and also evaluated in the analysis section of the report. The "tsk tsk" was confirmed and discussed during a meeting on August 22, 2005 held at MCA headquarters.

MCA Response:

Adopted

ANALYSIS

U.S. Comment:

Page 698, Section 2.1 Analysis Overview

It is suggested that this section begin with a discussion of the analysis methodology and proceed to explain how the various group activities supported that methodology.

MCA Response:

Adopted

Page 699, Section 2.1, Analysis of Airplane systems behavior:

This section states that "several parameters had invalid data."

Control wheel position data was one of the anomalous parameters; however, these data were available from the M-cab data (see comment for p. 701). The remaining invalid data did not inhibit the investigation. The report should be modified to reflect both of these points.

MCA Response:

Adopted

U.S. Comment:

Page 699, Section 2.1 Analysis Overview

Under the bulleted item titled "Anaysis [sic] of the Main Events," the draft final report states that the investigative team categorized the main events as being directly related to the accident, not directly related to the accident, or those that might be considered as normal during flight. The U.S. and French teams did not participate in such an effort, nor does it appear that the draft final report includes any such reference.

MCA Response:

Adopted

U.S. Comment:

Page 700, Section 2.1 Analysis Overview

This section states, in part:

> Two studies have been developed by the whole investigation tean [sic] jointly addressing both the:
> - Systems analysis (fault tree)
> - Crew behavior

The report should make clear that some of the material dealing with crew behavior in the analysis section was independently developed by the MCA and was not endorsed by the multi-national team.

MCA Response:

MCA was not able to identify any material independently developed and no such comment was presented by the French BEA

U.S. Comment:

Page 700, Section 2.1 Analysis Overview

This section states, in part:

> See section "2.6 Crew Behavior", Thread Overview Updates Cairo 26-Aug-05, Flash Air CBS Sub-group Comments (24 August 2005)"

If the CBS working group comments are to be included directly in the report, the final version of these comments, dated August 25, 2005 should be included, rather than the preliminary, incomplete August 24, 2005, version that is included here.

MCA Response:

Adopted

U.S. Comment:

Page 701, Section 2.2.1 General

This section states:

Several parameters were recorded in the FDR (related to the aircraft performance including):

- The movements of the pilot's controls:
  - Control column
  - Control wheel position (FDR data is not reliable)

While it is true that the control wheel data are not accurate as recorded on the FDR, the report should note that accurate control wheel data for the accident flight were available from the M-cab data and also from an NTSB study that involved application of corrections to match control wheel and aileron data. The M-cab data were the wheel positions required to match the roll angles and roll rates recorded on the FDR. As such, it

is a match that includes the control system model and the airplane aerodynamic model. Control wheel values developed by the NTSB study show good correlation with the M-cab data; the study also provides a likely explanation for the control wheel sensor fault.

Based on this information, the report should reflect the availability of the control wheel data.

U.S. Comment:

Page 710, Section 2.2.3, Conclusion (Sensitivity analysis):

Altitude was not one of the primary parameters matched for the M-cab simulations; rather, it is the result of the simulation attempting to match pitch attitude and vertical acceleration. Very small differences in column command would result in a more exact match of altitude, at the expense of matching pitch attitude.

MCA Response:

Adopted

U.S. Comment:

Page 716, Section 2.3.3 Flight Controls:

The first bulleted item states that the parameter for slat #1 was unreliable (showed mid extend position).

The FDR data indicate that one of the slat indication lights was illuminated for the entire 25 hours of the FDR recording, and this light may have been the subject of the discussion on the CVR at 02:30:21. However, there is no record that this fault was documented in the airplane technical log. Although minimum equipment list (MEL) restrictions permit operation of the airplane with this fault present, there are operational restrictions on airspeed. These restrictions were violated on all 13 flights recorded on the FDR.

MCA Response:

No factual data about the slat indication lights is available

U.S. Comment:

Page 716, Section 2.3.3 Flight Controls:

The fourth bulleted item states:

> Because the spoiler surface positions are not recorded in the FDR, any possible abnormality with the spoiler surfaces data can not be shown by the FDR.

Although flight and ground spoiler positions are not recorded on the FDR, the flight path

of the airplane is recorded. As the report correctly concludes, the motion of the airplane is consistent with the motion of the recorded control surfaces. Therefore, it can be concluded that no additional anomalous aerodynamic influences (e.g., spoiler abnormality) existed.

MCA Response:

See Analysis chapter, section 6.3.5 Spoiler Fault

U.S. Comment:

Page 716, Section 2.3.3 Flight Controls:

The last bulleted item states:

> A full analysis of the aircraft lateral control system has been done (refer to appendix 2-1 lateral control analysis). All the hypothetical failures in the

> system have been comprehensively studied. All the scenarios resulting from each individual failure (or combination of particular failures) were checked against the accident scenario. Most of the hypothetical failures scenarios were ruled out because of there inconsistency with the accident scenario. The remaining hypothetical failures scenarios showed consistency with the accident scenario. These hypothetical failures scenarios are as follows:

The remaining hypothetical scenarios were further examined because they could not be fully excluded based on a review of FDR data. There is no evidence to support a statement that the remaining hypothetical scenarios "showed consistency with the accident scenario." Consideration of the full investigative data did not support these scenarios.

As these statements highlight, the draft final report appears to have applied different standards to airplane issues versus operational issues. In most cases, the report considers airplane issues as possibly causal unless conclusive opposing evidence exists. Contrarily, operational issues are not considered causal (and in some cases not at all) unless proven to exist and influence the outcome of the accident.

U.S. Comment:

Page 753, 2.5.5.1 Conditions which could lead to this event

This section states:

> Although the rudder surface movement can contribute to this event, the rudder position as shown by the FDR at this interval of time was very small. The finding of having the rudder related to this event can only be accepted if consideration is given to the data received from Boeing in response to operator reports of abnormal flight control behavior related to rudder trim position and Boeing's interpretation of rudder trim effect on lateral control as being a possible cause of airplane rolling back to wings level and slow turn towards right due to the out of trim condition See Appendix 2-2 Studies of other airplane incidents relevant to autoflight systems. Case II "Autopilot Overbank

During the investigation by the multinational investigation, the rudder was ruled out as a possible contributor to the accident. In fact, the draft final report includes scenario tree pages showing the rudder ruled out (e.g., page 759 of draft final report). The rationale provided here and attributed to Boeing is misleading.

The event referred to in this section occurred on a different 737. The operator reported an autopilot overbank and provided the FDR data to Boeing for analysis. The FDR data indicate that the airplane experienced an overbank while attempting to engage the autopilot in an out-of-trim condition due to a rudder deflection of approximately 3 degrees. For more information on this event, see comments regarding page 980 of the draft final report.

In the Flash Airlines case, the FDR data shows that both the rudder and rudder pedals were very nearly zero, a fact that is confirmed by the simulation analysis, which shows that the airplane's path is consistent with the recorded position of the control surfaces (including the rudder). This event is not relevant to the Flash Airlines accident.

The earlier conclusion that the rudder can be ruled out is correct and should be reflected in the final report.

MCA Response:
Adopted

U.S. Comment:

Page 756, Section 2.5.5.3 Roll Left and beginning of Left Turn possible causes

This section states, in part:

> The aircraft remained near heading 140 for 9 seconds. Roll rate decreases as aircraft nears 140.

This section should make it clear that the trend in roll rate continued, with some brief oscillations, as the airplane slowly rolled from left to right. Although the airplane's heading briefly remained near 140 degrees as the airplane passed through a wings-level flight attitude, the airplane's bank angle did not stabilize.

Page 772, Section 2.5.6 Pitch up and airspeed decay

This page states:

> The possible conditions which might lead to this event are shown in the following:
>
> 1. Pilot Wanted to Gain Altitude Quicker (Intended Maneuver)
>   This probability may be supported by the fact that the airplane should intercept the VOR radial at a minimum of 11,000 ft
> 2. Pilot Following Erroneous FD (intended)
>   There are not enough data to rule in or rule out this probability
> 3. Relaxation of Control in Out of Trim Condition (Unintended Maneuver)
>   The results from the M-CAB tests match with FDR
> 4. Autopilot Fault (Unintended Maneuver)
>   This condition might be ruled out. This event started prior to AP Engagement (based on FDR data)
> 5. Stab Trim Fault (Unintended Maneuver)
>   This condition might be ruled out. Based on FDR data, the stabilizer did not show abnormal behavior throughout the flight.
> 6. Pilot pulling on the control column (unintentional)

Conclusion:
With the exclusion of the ruled out (conditions 4 and 5), the investigation could

not determine a higher possibility to any of the remaining conditions (conditions 1, 2, 3 and 6) based on the given data.

In all cases, this event does not have direct relation to the accident

The following information and suggested changes are provided:

For condition 1, it is suggested that the word "probability" be changed to "possibility." It is not reasonable to intentionally pitch up the airplane and allow airspeed to decay below flaps-up maneuvering speed to gain altitude. In addition, the right bank began at about the same time as pitch reached its maximum value. The right bank was clearly inconsistent with the flight crew's departure clearance. This suggests that the captain was not adequately monitoring pitch or bank indications. In addition, the existence of a published altitude crossing restriction over the SHM VOR has not been well documented in the report.

For condition 2, the evidence indicates that the autopilot's automatic transition from command mode to CWS/R, which occurred during the time of pitch up and airspeed decay, happened because the captain was not closely following roll commands on the flight director. This conflicts with the possibility that the captain was closely following an erroneous flight director.

A seventh possible explanation for the pitch up and airspeed decay should be added in this section. This possibility, discussed during the August 2005 meeting of operational factors investigators and crew behavior subcommittee members and included in the August 25, 2005 CBS group comments, was that the captain may have become distracted from his primary flight control task. This bullet should be combined with bullets 3 and 6, which would both be consistent with the captain's distraction.

With respect to the concluding statements, it should be acknowledged that the conclusion stated here was not agreed to by the multinational team. The available evidence best supports a conclusion that the pilot became distracted from monitoring aircraft attitude information.

U.S. Comment:

Page 782, 2.5.7.2.2, The conditions leading to the event of engaging the autopilot are presented in the following:

The statements under bullets 1, 2, and 3 should state that the Boeing procedure is for the "pilot flying" to push the CMD button, not the "captain."

MCA Response:
Corrected

Page 785, Figure 2.5.7.4 Autopilot Engage Attempt with Time CVR Data

This figure contains a notation attributing the CVR statement "Not yet" to the observer. However, this statement was attributed to the captain in the final version of the CVR transcript

The attribution of this statement in the figure should be made consistent with the final

version of the CVR transcript.

MCA Response:

Corrected

U.S. Comment:

Page 794, 2.5.9 Aileron move in direction of right roll

A. Rudder surface movement:

This portion of the scenario tree is examining possibilities for aileron motion. Rudder motion does not cause aileron motion. The investigation previously ruled out the rudder (ref page 796 of draft final report), and the final report should reflect so.

MCA Response:
Adopted

U.S. Comment:

Page 794, 2.5.9 Aileron move in direction of right roll

The draft final report indicates that a slat asymmetry was evaluated in the M-cab.

Slat failure analysis was not done in the M-cab. The final report should note instead that the simulations were conducted on computer workstations.

MCA Response:
Adopted

U.S. Comment:

p. 795, Conclusion

The conclusion at the bottom of the page states:

> The investigation could not determine a higher possibility to any of the above findings (lateral system fault, pilot input) based on the given data.

There is no evidence of a lateral system fault, and it is suggested that the conclusion on this page can only be attributed to pilot input.

Page 803, Section 2.5.10 Autopilot Disengagement indications on the FDR and CVR

The sixth bullet on this page should note that the increase in pitch and the decay in airspeed began prior to autopilot engagement.

Page 811, Section 2.5.10 Autopilot Disengagement indications on the FDR and CVR

The statement that "the sensed pressure is not recorded on the FDR" should be rephrased to avoid misperceptions that it erroneously did not record the data. It is suggested that the sentence read, "the FDR does not record data regarding the hydraulic pressure at the autopilot aileron hydraulic switch."

MCA Response:
Adopted

U.S. Comment:

Page 814, Section 2.5.10.2 Autopilot Disconnect Analysis (based on FDR and CVR available data):

see same comment as provided for p. 785

MCA Response:
Adopted

U.S. Comment:

Page 815, Section 2.5.10.3 Probable conditions for autopilot disconnect:
1.1 Manual Disconnect

This section states:

Warning length is consistent with "double click" typical of manual disconnects (within allowable warning duration tolerance)3. However, there is no disengagement callout by crew on CVR. In addition, the autopilot disconnect switches status on the control wheels horns are not recorded in the FDR.

This section should acknowledge the following information. The minimum time that the Mode Control Panel (MCP) will sound the autopilot disconnect warning when the autopilot disconnect button is pressed twice (i.e., "double click") is 1.5 seconds; the maximum time is 3.0 seconds, as provided in Honeywell's MCP Component Maintenance Manual document 22-11-84. Based on the CVR data, the autopilot disconnect warning lasted 2.136 seconds, which is within the allowable warning duration of 1.5 seconds (lower limit) and 3.0 seconds (upper limit).

Lack of conversation about autopilot disconnect on CVR could also suggest that the disconnect was expected and therefore a manual disconnect.

The statement at the end of the paragraph that "the autopilot disconnect switches status oh the control wheels horns are not recorded in the FDR" should be rephrased to avoid misperceptions that it erroneously did not record the data. It is suggested that the statement read "The FDR does not record data regarding the autopilot disconnect switch on the control columns."

MCA Response:

- Boeing presentation (see 2.5.10.2) regarding autopilot function states that the duration of autopilot manual disconnect warning is less than 2 seconds

- Honeywell verbal information, states the duration of autopilot manual disconnect warning is max of 3 seconds

- Actual time of warning based on CVR is 2.136 seconds

Although requested, Honeywell did not supply the investigation team with any supporting evidence.

U.S. Comment:

Page 815, Section 2.5.10.3 Probable conditions for autopilot disconnect:
2. Case of Autopilot Does Not Engage

This case can be ruled out because the FDR shows that the autopilot did engage and the disconnect warning can be heard on the CVR.

MCA Response:
Adopted

U.S. Comment:

U.S. Comment:

Page 815, Section 2.5.10.3 Probable conditions for autopilot disconnect:

The conclusion states:

> The investigation could not determine a higher possibility to any of the above findings (Autopilot automatically disengaged or manually disengaged), based on the given data.

The data indicate that the autopilot disconnect was a manual disconnect initiated by the crew. From this point until the end of the flight, the FDR records that the autopilot remained disengaged.

MCA Response:

This is not consistent with the outcome of the fault tree and the CVR information

U.S. Comment:

Page 815, Section 2.5.10.3 Probable conditions for autopilot disconnect:

Footnote 3 on this page states "Verbal information from Honeywell but not documented"

The report should reflect that this information is provided in Honeywell's MCP Component Maintenance Manual document 22-11-84, revision 11, dated 15Jan2005, page 198.209

U.S. Comment:

Page 820, Section 2.5.11.1 Conditions which could lead to this event
A. Rudder surface position"

This portion of the scenario tree is examining possibilities for aileron motion. Rudder motion does not cause aileron motion. The investigation previously ruled out the rudder (ref page 796 of draft final report).

MCA Response:
Adopted

U.S. Comment:

Page 821, Section 2.5.11 Airplane begins roll to right, Subsection 2.5.11.1 Conditions which could lead to this event

Section F on this page states:

F- Flight Crew Believes Autopilot is Engaged When it is not
Reference to FDR, CVR data and Crew Behavior studies, this condition could not be ruled out

It is suggested that this section be revised, since no evidence is provided to support this possibility. The CVR records that the autopilot disconnect warning sounded prior to the beginning of the right bank. On several later occasions, the captain requested that the autopilot be engaged.

MCA Response:

CVR clearly records F/O announcement “Autopilot in command” and later “No autopilot commander”. This strongly supports the above statement “F”

U.S. Comment:

Page 822, Section 2.2 Uncommanded (actuator faults only)

An uncommanded aileron control system input from an aileron autopilot flight control actuator requires three separate faults to be present simultaneously within the actuator: the arm solenoid commanded open, the detent solenoid commanded open, and the transfer valve spool jammed off center. Had any one of these three faults been present during the autopilot engage sequence, the autopilot would not have engaged. All three faults result in force applied to the wheel. This will only lead to airplane roll if the crew does not oppose the motion of the wheel. The FDR show aileron motion in both directions, which indicate that the crew was actively controlling the airplane. Therefore this condition can be ruled out.

MCA Response:

Not adopted. See section 2.5.13

U.S. Comment:

Page 823, Section 3.4 Trim/Feel Unit Fault

This fault results in force being applied to the aileron control system, resulting in both of the control wheels and the ailerons moving to a uncommanded position corresponding to the force applied to the system. This will only lead to airplane roll if the crew does not oppose the motion of the control wheel.

Following the disengagement, and as the airplane continued to roll to the right, the FDR data indicates aileron deflection rates well in excess of the rates 0.6 degrees per second

that the aileron trim actuator can command. The aileron deflection rates indicated on the FDR can only be achieved through manual aileron control wheel inputs.

Furthermore, the investigation group evaluated the aileron trim runaway failure scenario in the Boeing Multipurpose Engineering Cab (M-cab) simulator. This scenario was demonstrated by investigators to be easily identified and controllable during the flight simulations, with only 15 pounds of control wheel force required to return and maintain the aileron control surfaces at the neutral position. Aileron motion in both directions indicates that the crew was actively controlling the airplane.

Based on this evidence, this condition can be ruled out.

MCA Response:

Not adopted. See section 2.5.13

U.S. Comment:

Page 848, Section 3.0 Rudder Surface Deflection

During the investigation by the multinational team, the rudder was ruled out as a possible contributor to the accident. The draft final report includes scenario tree pages showing the rudder ruled out (e.g., page 759). The rationale provided on p. 848 and attributed to Boeing is misleading.

The event referred to by this paragraph occurred on a different 737. The operator reported an autopilot overbank and provided the FDR data to Boeing for analysis. The FDR data indicate that the airplane experienced an overbank while attempting to engage the autopilot in an out-of-trim condition due to a rudder deflection of approximately 3 degrees. For more information on this event, see comments regarding page 980 of the draft final report.

In the Flash Airlines case, the FDR data shows that both the rudder and rudder pedals were very nearly zero, a fact that is confirmed by the simulation analysis, which shows that the airplane's path is consistent with the recorded position of the control surfaces (including the rudder). This event is not relevant to the Flash Airlines accident.

The earlier conclusion that the rudder can be ruled out is correct and should be reflected in the final report.

MCA Response:
Adopted

U.S. Comment:

Page 850, Section 6.1.1.2 Following Erroneous EADI

The section on this page titled "6.1.1.2.2 Alternate Instruments Not Cross-Checked" section states:

> From the Crew Behavior Subcommittee study, this condition could be ruled out.

This section should be revised. There was no joint CBS study conclusion that the flight crew cross-checked their instruments.

MCA Response:
Adopted

U.S. Comment:

Page 850, Section 6.1.1.4 Pilot Loses Situational Awareness

The subsection on this page tilled "6.1.1.4.1 Captain experiences SD Type II" states:

> See Section 2.6.1 Crew Behavior Subcommittee, this condition could not be ruled out

It should be further stated here that loss of situational awareness and spatial disorientation for the captain is consistent with available data and with CBS group comments from 25 August 2005.

U.S. Comment:

Page 852, Section 6.2.2.3.1.1
Both Solenoids and Transfer Valve Jammed (Autopilot actuator, both Solenoids and Transfer Valve Jammed (Actuator Hardover without Force Limiter 17 to 20 Ib Force)

The report states that "the cause of these failures cannot be conclusively identified."

However, it is known that these faults were not present during the autopilot engage sequence. This hypothetical scenario would require that the faults occur after the time the autopilot was engaged. Furthermore, it would result in relatively small forces applied to the wheel. The M-Cab evaluations found that this condition is easily controllable by a crew aware of their attitude. It would only lead to airplane roll (and overbank) if the crew does not oppose the motion of the wheel. Aileron motions recorded on the FDR indicates the crew was actively controlling the airplane.

Based on this evidence, this condition can be ruled out.

MCA Response:

Refer to the analysis in 6.2.2.3., which shows close consistency with the existing data

U.S. Comment:

Page 854

This page states, in part:

> Therefore, it could be concluded that this hypothetical condition shows close consistency with the event. This condition is also consistent with the possibility of recovering the airplane when appropriate quantity of input is applied timely on the airplane (M- Cab tests).
>
> (See also section 2.6 Crew Behavior)
> This condition could not be ruled out

These conclusions should be clarified. It is unclear which parts of section 2.6 support this conclusion. The CBS group concluded that the appropriate action to take at high angles of bank, prior to recovery, was to apply full opposing aileron. The hypothetical fault described in this section would not have prevented the crew from doing this. This scenario was demonstrated to be easily controllable in the M-Cab by pilots who were aware of their attitude. This hypothetical fault by itself cannot explain the continued right roll to overbank.

MCA Response:

This scenario was demonstrated to be easily controllable by pilots who were aware of the hypothetical fault and identified the required corrective action.

U.S. Comment:

Page 863, Section 6.3.4 .2 Aileron Trim Runaway to 60 deg.

A bullet under the heading of this section titled, "This condition could not be ruled out based on the following" states:

- Consistent with Crew Behavior study

This statement should be clarified or further supported. This fault was not explicitly addressed in any of the crew behavior subcommittee documentation.

In addition, it should be noted that all pilots were able to easily control this fault in the M-Cab. Assuming this fault existed, the captain would have been able to move the ailerons towards neutral with approx 20 lbs of force. There is no explanation given here as to why the captain could not have applied the small additional force to roll back to wings level. During the recovery attempt, the FDR data shows the crew was able to achieve high roll rates towards wings level. Even in the presence of this assumed fault, the crew inputs cannot be explained if the captain was aware of the airplane attitude, suggesting the presence of spatial disorientation.

U.S. Comment:

Page 888, Section 6.3.5.3.1 Scenario 10 - Spoiler wing cable jam

This section stales:

> This condition could not be ruled out, based on the following:
>
> The results obtained from the M-Cab test show a very close consistency with the FDR data which may explain this event. The estimated aileron wheel forces needed to move the wheel to correct for the right turn tendency is ~ 50 lbs. The timing and length of the Captain speeches through this event does not provide sufficient information to verify the effect of this force on the speech tone

This conclusion should be revised.

If this fault had existed, the captain would have been able to move the ailerons towards neutral with approximately 50 lbs of force. It is reasonable to expect the captain would have been able to apply the additional force necessary to roll back to wings level. The M-Cab work demonstrated that all participants were able to apply in excess of 80 lbs to the wheel to control the airplane. This scenario is not consistent with the M-Cab results. The M-Cab results demonstrated that participants could apply in excess of 80 lbs to the wheel to control the airplane.

Furthermore, at the time this fault is postulated, the airplane was already banked in excess of 25 degrees to the right. No explanation is given to explain how the airplane reached 25 degrees right bank.

The last line of this section states:

Crew behavior study shows consistency

This statement should be removed. The CBS group documentation does not address this scenario, and it does not reflect discussions by the CBS group.

MCA Response:

This scenario was demonstrated to be easily controllable by pilots who were aware of the hypothetical fault and identified the required corrective action when the required additional force was 50 lbs and not the case of 80 lbs.

U.S. Comment:

Page 894, 6.3.5.3.2 Scenario lOa - F/0 wheel jam (F/0 wheel jam) offset of the neutral position at time 92450 (maximum wheel deflection).and clears at 92472

The section states, in part:

> - All the parameters obtained from the M-Cab test with the fault inserted show very close consistency with the accident flight FDR data

This conclusion should be revised. This scenario is not consistent with M-Cab results. The M-Cab results demonstrated that participants could apply force in excess of 80 Ibs to the wheel to control the airplane. Furthermore, at the time this fault is postulated to have occurred, the airplane was already banked in excess of 25 degrees to the right. No explanation is given to explain how the airplane reached 25 degrees right bank.

The section states, in part:

> This condition could not be ruled out, based on the following:
>
> The results obtained from the M-Cab test show a very close consistency with the FDR data which may explain this event. The estimated aileron wheel forces needed to move the wheel to correct for the right turn tendency is ~ 50 Ibs or slightly higher. The timing and length of the Captain speeches through this event does not provide sufficient information to verify the effect of this force on the speech tone

This conclusion should be revised. Assuming this fault existed, the implication is that the captain was able to move the ailerons towards neutral with approx 50 Ibs of force. It is therefore reasonable to expect the captain would have applied the additional force necessary to roll the airplane back to wings level. The M-Cab work demonstrated that all participants were able to apply in excess of 80 Ibs to the wheel to control the airplane.

The last line of this section states:

> Crew behavior study shows consistency

This statement should be deleted. The CBS group documentation does not address this scenario, and it does not reflect discussions by the CBS group.

MCA Response:

This scenario was demonstrated to be easily controllable by pilots who were aware of the hypothetical fault and identified the required corrective action when the required additional force was 50 lbs and not the case of 80 lbs.

U.S. Comment:

Page 894, 2.5.13 Right roll continues to overbank with ailerons activities

A conclusion section should be added to summarize the information regarding the right bank continuing to overbank. The evidence suggests that captain's spatial disorientation was the most likely cause for the overbank.

U.S. Comment:

Page 901, Figure, 13.0 Right Roll Continues to Overbank with Aileron Activity

According to Rockwell Collins, the EFIS Failure Mode Effect Analysis (FMEA) does not list any potential failure modes which would result in the failure indication of "Offset Airplane Reference." This failure mode has never been reported in the operational history of EFIS-equipped Boeing 737, 757 and 767 aircraft.

The report should be amended to account for this information, and the report should delete the statement, "Boeing to ask Rockwell Collins if this fault can actually occur."

MCA Response:
No official information from Boeing or Rockwell Collins has been received (fault tree page 7 of 22)

U.S. Comment:

Page 919, 2.5.14 Flight crew CVR autopilot announcements

This section states, in part:

> Flight crew CVR autopilot announcements might be explained by the following:
>
> 1. Requests for Autopilot Engagement
>
> This scenario is consistent with expected normal airplane operation. If the Captain asked for autopilot and the F/0 pressed the CMD button, the interlocks would not be satisfied because of forces on the control wheel. In this case, the button push is not recorded as an autopilot engagement on the FDR.
> (Done on M-Cab)

It is suggested that this section further note that the command "Autopilot" is not only standard terminology used to request the autopilot, but was used by the captain earlier in the flight to request the autopilot. Furthermore, according to the FDR, there were no indications on the flight deck that the autopilot was already engaged when the captain began calling for the autopilot during this period in the flight.

Engaging the autopilot may be an appropriate response if the pilot was not aware of the true attitude of the airplane.

MCA Response:

No evidence supporting this statement.

This section also states, in part:

> 4. Announcement of Perceived Autopilot Behavior

The report should specify which flight crew statements could be explained by this item. There is no reason to believe the captain and the first officer's statements during this period were announcements of perceived autopilot behavior. Indications on the flight deck were that the autopilot was off at this time. Flight crew statements are consistent

with attempts to engage the autopilot. The data do not support this explanation of the flight crew's autopilot announcements.

hMCA Response:

CVR clearly records F/O announcement “Autopilot in command” and later “No autopilot commander”.

This section also states, in part:

> 5. Requests for Autopilot Disengagement
> This condition requires perception on the part of the Captain that the autopilot is engaged

It is suggested that evidence conflicting with this explanation be included here. This explanation is highly unlikely because "Autopilot" is the standard terminology used to request that the autopilot be engaged, and was used by the captain earlier in the flight to request the autopilot. In addition, it is unlikely that the PF would repeatedly request that the PNF disconnect the autopilot, as each pilot has a disconnect button on their own control wheel. Furthermore, FDR data indicate that there were no indications in the cockpit during this time that the autopilot was engaged.

MCA Response:

CVR clearly records F/O announcement “Autopilot in command” and later “No autopilot commander”.

This section also states, in part:

> The investigation could not determine a higher possibility to any of the above conditions based on the given data.

It is suggested that this conclusion be revised. It pre-supposes that items 1-5 are mutually exclusive, and they are not. Items 1, 4, and 5 all refer to the captain's pronouncements of "Autopilot" and they are mutually exclusive explanations for these announcements. Items 2 and 3 refer to different announcements.

The meaning of the flight crew's statements regarding the autopilot during this period are unambiguous. The captain's "autopilot" statements are consistent with requests for autopilot engagement. The first officer's statement, "Autopilot in command" is consistent with a rote response following a press of the command button. The first officer's statement, "No autopilot commander" is consistent with an attempt to communicate to the captain that the attempt to engage the autopilot was unsuccessful.

MCA Response:

MCA does not agree with this statement as it is highly speculative and not supported by factual information.

p. 962,1- CASE of "AUTOPILOT REPORT OF EXCESSIVE RATE OF DESCENT"
1 - BOEING REPLY, EXCESSIVE RATE OF DESCENT

Discussion of this case includes correspondence between Boeing and a different operator concerning a report of excessive rate of descent while using autopilot A. The fault was the result of an intermittent column cutout switch that prevented the autopilot from commanding the required stabilizer trim. The autopilot lacked sufficient authority to overcome the out-of-trim condition.

In the Flash Airlines case, the FDR data shows that the autopilot was engaged for only one interval of 3-4 seconds. There is no evidence of an excessive descent rate during

those 3-4 seconds, nor is there any evidence of insufficient autopilot authority. Therefore, this event is not relevant to the Flash Airlines accident.

The details and correspondence of the event involving the excessive rate of descent have been previously provided but are provided again for the MCA's reference.

-Event Summary-

On 21 Oct 04, the operator reported that one of their 737-500 airplanes had experienced an autopilot anomaly described as follows:

Pilot Report - After airborne and approaching flight level 120, "ALT ACQUIRE" comes on the FMA then the A/C descended with V/S }800ft/min to flight level 116 (with A/P A engaged only).

The operator further reported that the fault had repeated on a number of occasions (always with autopilot A) and maintenance actions that had been taken in an attempt to correct the fault and requested assistance from Boeing.

From 21 Oct to 6 Dec, Boeing and the operator exchanged troubleshooting recommendations and test results. On 1 Dec, the operator requested on-site engineering support to result the recurring fault. A Boeing engineer traveled to Cairo to assist the operator. During the on-site work, an intermittent fault was found in the column cutout switch for autopilot A. It is suspected, that the high resistance of the Sl closed contacts resulted in the FCC intermittently detecting the Sl as open when the contacts were actually closed. This condition would inhibit the trim up command output from the A channel autopilot. This fault condition correlates to the FDR data that showed the A channel would not trim up when expected resulting in a loss of elevator authority and subsequent increase in descent speed. This fault condition also correlates to the report that proper trim up returned once the B channel Autopilot was engaged.

The operator replaced the faulty switch. Booing has received no further reports of this condition.

U.S. Comment:

p. 980, II- CASE of AUTOPILOT OVERBANK
1- Case of Overbank Follow up:

Discussion of this case includes correspondence between Boeing and a different operator concerning a reported autopilot overbank event that resulted from attempting to engage the autopilot with the airplane out-of-trim due to non-zero rudder deflection.

In the Flash Airlines case, the FDR data shows that both the rudder and rudder pedals were very nearly zero, a fact that is confirmed by the simulation analysis that shows that the airplane's path is consistent with the recorded position of the control surfaces (including the rudder). This event is not relevant to the Flash Airlines accident.

The details and correspondence of this event have been previously provided but are provided again for the MCA's reference.

-Event Summary-

On 27 Mar 2005, the operator reported that one of their 737-500 airplanes had experienced an autopilot anomaly described as follows:

During departure with LNAV engaged, AP "B" selected, the AP "B" engaged then disengaged. After satisfying F/D, again AP selected. At UTC 20:14 the autopilot gave more than 35 degree bank angle and increased. A/P disconnected followed by F/D pitch bar out of view, F/D switches recycled. Flap retraction and leveled, AP selected and operation normal.
The operator provided the FDR data for analysis.

On 28 Mar 2005, Boeing provided the following analysis to the operator.

The FDR data indicate that the airplane experienced an overbank during an attempted autopilot engage because the airplane was in a small nose-left sideslip as the result of rudder pedal being deflected to approximately 1.5 degrees nose left. The reasons for this are unknown and cannot be determined from the FDR data, but the trim likely arose either from crew trim inputs during the takeoff roll (possibly inadvertent) or from something sticking in the rudder feel and centering unit. The simulation confirms that the sideslip resulting from the pedal input would have required approximately 25 degrees of right control wheel deflection to maintain wings level flight, as indicated by the FDR data. During each attempt to engage the "B" autopilot, the wheel was released to neutral and the airplane rolled at between 2 and 2.5 deg/sec as a result of the sideslip-induced roll.

Boeing has received no further reports of this condition.

U.S. Comment:

Page 992, 2.6.1 Flash Airlines Flight 604 Investigation Crew Behavior Subcommittee

This section of the report states, in part:

> Examination of evidence pertaining to specific phases of the accident
> 1. From the roll input that initiated a right roll from wings level (from around time 104) through the statement by the Capt, "how turning right", (around time 02:44:37), the committee agrees that the above three conditions are met, and it is therefore possible that the Capt was experiencing type I Spatial Disorientation.
> 2. From the statement by the Capt, "How turning right", to the beginning of sustained left roll (around time 158), evidence for orientation or disorientation is inconclusive given currently available data.

3. After the first officer says "no autopilot commander" and sustained left control inputs begin the committee agrees that there is evidence that someone was properly oriented and manual recovery of the aircraft was initiated.
4. The committee agrees that there is no evidence suggesting spatial disorientation on the part of the first officer.
5. The committee agrees that the flight crew exhibited some positive CRM-related behaviors during the flight; however, further analysis in this area is required.

Closing Comments

This is a preliminary report. More work is needed to comprehensively address all human factors issues relevant to this accident, as needed.

This page contains an excerpt of the minutes of the first meeting of the Crew Behavior Subcommittee, held in August 2004. These preliminary investigative materials should not be included in the report. The crew behavior subcommittee did not adopt these points as its final conclusions during the final meeting of the group in August 2005. In fact, the full range of investigative evidence available by August 2005 did not support preliminary conclusions 2 and 5.

Point 2, which states that evidence for spatial disorientation after the captain's statement "how turning right" was inconclusive, was a preliminary conclusion pending simulation work and the development of systems group conclusions about the functioning of aircraft systems. Evidence for the captain's spatial disorientation was considered inconclusive in August 2004, because Egyptian officials insisted that there had been a systems malfunction that would account for control surface movements after the captain's statement, "how turning right." However, subsequent investigative work ruled out the likelihood of a lateral control systems malfunction. Therefore, type II spatial disorientation is the most likely explanation for the captain's continued inappropriate manual control inputs, and the evidence indicates that the captain's spatial disorientation persisted at least until the beginning of the attempted recovery maneuver.

Point 5 was superseded by later investigative work. During its August 2005 meeting, the crew behavior subcommittee identified a number of deficiencies in the CRM-related behaviors of the flight crew. These deficiencies should be discussed in the report.

MCA Response:

All crew behavior subcommittee work has been included in the report with no differentiation between preliminary and otherwise.

The report reflexes the interpretation of the Egyptian Investigation Team and specialized advisors.

This applies to all U.S. comments regarding Section 2.6

U.S. Comment:

Page 993, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior

Subcommittee August 2004

This section states, in part:

> According to the meeting held on Aug. 23 - 26, 2004 and attended by representatives from NTSB, BEA and Boeing. The committee agreed that the Captain was possibly experiencing "Type I Spatial Disorientation" in the 1st stage of the accident.
> In the 2nd stage the evidence of "Spatial Disorientation Type I" is inconclusive.

In the 3rd stage there is no evidence of this disorder.

The statements above are the MCA's interpretation of the August 2004 preliminary findings of the crew behavior subcommittee, which were developed based on the MCA's assertion that a lateral control system malfunction had occurred. The statements on this page were not jointly developed, nor endorsed by all members of the CBS group. The full range of evidence developed during the course of the investigation points to spatial disorientation as the most likely explanation for the captain's control inputs mid-way through the upset. The evidence suggests that the captain was experiencing type II spatial disorientation during this stage of the event.

It is suggested that the term "disorder" not be used to describe the occurrence of spatial disorientation in the aviation environment. Spatial disorientation is a normal human response to the accelerations of flight when accurate visual information about attitude is either not available or is not adequately monitored.

It is suggested that the remainder of section 2.6.2, pages 993-998, be labeled as work developed independently by the MCA.

MCA Response:

See MCA previous comment

U.S. Comment:

Page 993, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

This section states, in part:

On 15 February, 2005 a message was received from NTSB including analysis of
the Captain Behavior.
The scenarios included the word "Confusion "and not "Spatial disorientation type I"

It is suggested that excerpts from the NTSB message referred to here be included in this section of the report. The purpose of this reference is unclear.

U.S. Comment:

Page 993-994, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

The discussion of the term "confusion" on p. 993 should acknowledge that spatial disorientation can cause confusion about aircraft attitude.

The table on page 994 should be clearly labeled as work performed independently by the

MCA. The multinational CBS group did not jointly perform or endorse this material.
The table should also be revised. It appears to have been developed to provide criteria for distinguishing among four different psychological states or conditions. However, the labels confusion, spatial disorientation type I, distraction, and mistake are not mutually exclusive psychological states or behaviors. They are not adequately defined in this section, and no scientific research is referenced to support the attributes assigned to them.

U.S. Comment:

Page 995, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

This section states, in part:

> Captain:
> We apply the above table to the circumstances of the accident. The highest probability is that the captain suffered from distraction accuracy during the 1st stage only.

The meaning of "distraction accuracy" should be clarified.

U.S. Comment:

Page 995, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

The section states, in part:

> The captain was the 1st to attract attention of the rest of the crew that something wrong is happening in the airplane "see what the airplane is doing ".

The quote "See what the airplane is doing" should be modified so that it is consistent with the CVR transcript, which documents the captain's statement as "See what the aircraft did." The interpretation of the captain's statement should be modified as well. The captain's statement suggests surprise at aircraft behavior, but it does not provide evidence determining whether this aircraft behavior was normal or abnormal. This statement occurred soon after the flight crew attempted to engage the autopilot, and the autopilot transitioned to CWS-R mode. The transition to CWS-R mode occurred because the captain was not closely following flight director guidance at the time of autopilot engagement. Although this occurred in accordance with nominal system operation, it was an unusual occurrence that the captain may not have expected or understood, and it likely explains the captain's statement, "See what the airplane did."

MCA Response:

Corrected

U.S. Comment:

Page 995, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

The section states, in part:

This was shared by other crewmembers, as they assisted the captain in the same direction. Their observation and responses were centered on "right bank" and "autopilot".

The first sentence should be revised. The meaning of the statement "This was shared by other crewmembers" is unclear.

U.S. Comment:

Page 995, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

The section states, in part:

> Captain was alert with good concentration in the 2nd and 3rd stage as shown by his orders, responses and 3 appropriate actions taken (to the left):
> - 1st action Lt input after words "How Right"
> - 2nd action Lt input "OK come out"
> - 3rd action Lt input "OK come out"

It should be acknowledged that captain could have been alert and concentrating but remained affected by type II spatial disorientation. Lack of alertness is not a prerequisite for spatial disorientation.

The statement, "3 appropriate actions taken (to the left)" should be revised to acknowledge that during the 24 seconds between the captain's response, "What" and the beginning of appropriate control inputs consistent with an attempted recovery maneuver, only two control wheel inputs left of neutral were recorded, and these inputs lasted less than two seconds each. All other recorded inputs were right of neutral. Taken together, this evidence indicates that the captain's control wheel inputs during this period were predominantly to the right.

U.S. Comment:

Page 995, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

The section states, in part:

> During 1st stage (critical stage) there was signs indicating astonishment (How Right) also signs of Hesitation (turning right sir).

This statement should be revised so that the statements match the CVR transcript and that the person making each statement is clearly identified. Also, the statement that there were signs of "hesitation" with respect to the first officer's statement "turning right sir," should be better explained.

U.S. Comment:

Page 995, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

This section states, in part:

> 1st period (Pre-critical)
> There were talks in between all crew members and between crew members and A.T.C. and attendant. Answers and comments are immediate and correct pointing

to normal orientation and concentration. The mode and content of sentence show no evidence of disturbance of mood or intellectual functions. The conversations

were calm and decisive with no evidence of anxiety or tension. There is no evidence of Euphoria or depressed mood.

This summary of flight crew communications should include information about CRM deficiencies discussed during the August 25, 2005, meeting of the crew behavior subcommittee.

U.S. Comment:

Page 995, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

The section states, in part:

> 2nd period (Critical)
>
> Starting by the phrase "Eddilo" (time 2:44:1) this was followed in few seconds by an important observation of the captain indicating that something is going wrong with the airplane.
>
> This was followed by a 1-— period of hesitation, astonishment lasting for less than ten seconds.

This section should be revised. The "important observation of the captain indicating that something is going wrong with the airplane" referred to here appears to be the captain's statement "See what the aircraft did." As discussed earlier, this does not indicate that something was wrong with the airplane, as is implied here.

The captain's lack of speech for a number of seconds after his statement "See what the aircraft did" does not indicate that the captain was hesitating or was astonished. It simply indicates that he was not engaged in communication with the first officer. It is not possible to determine where his attention was focused during this time. However, the lack of control inputs that were needed to counteract the developing right bank suggests that the captain was distracted from monitoring attitude information during this time.

U.S. Comment:

Page 995, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

The section states, in part:

> All crewmembers are anxious during this period of hesitation and astonishment ended by the captain saying "how turning right ".

This statement should be deleted. There is insufficient evidence to document the mood of the two pilots and the observer during the ten seconds preceding the captain's statement "how turning right."

U.S. Comment:

Page 996, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior

The section states, in part:

> Both F.O. and extra crew 1 did not contradict the captain's orders or actions until the end of accident. This shows that in their estimation the captain was acting in the proper way.

The failure of the first officer to take more assertive action to reverse the direction of roll does not provide evidence that he believed the captain was acting properly. Rather, it indicates that he did not have the skills or did not feel adequately empowered to take assertive action. In fact, the first officer's "tsk, tsk" vocalization, confirmed during the August 2005 meeting of the crew behavior subcommittee meeting, was interpreted by some group members as a sign of frustration with the captain. This contradicts the assertion that the first officer believed the captain was acting in a proper way as he rolled the airplane into the overbank.

U.S. Comment:

Page 996, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

The section states, in part:

> If they felt he is wrong they would have (at least) suggest any other action. As the crew were in stress this logically abolishes the respect of seniority.

This statement is unsupported. Numerous accident investigations have documented the failure of junior crew members to challenge a captain's inappropriate actions. Moreover, past accidents have demonstrated that stress does not necessarily abolish deference to authority among junior flight crew members.

Page 996, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

The section states, in part:

> If captain is acting wrongly they would have screamed loudly and aggressively there is no evidence of this (C.V.R.).

This statement should be revised because it is contradicted by evidence on the CVR. The first officer's voice became noticeably louder as the overbank grew more severe and the captain failed to correct it. However, the first officer did not escalate his assertiveness by providing direction, issuing commands, or taking timely control of the airplane. The investigation revealed that he had not been provided with CRM training, which could have provided him with better skills for intervening in this kind of situation.

Pages 997-998, Section 2.6.2 Flash Airlines Flight 604 Investigation, Crew Behavior Subcommittee August 2004

The report should acknowledge that the fault tree diagrams on these pages were modified independently of the full investigative team.

MCA Response:

All fault tree diagrams included in this report have been the outcome of work processed by Boeing through meeting in Cairo and email communication with no changes affected to it by any single party.

U.S. Comment:

Pages 1000-1006, Section 2.6.3 Flash air CBS Sub-group comments (24 August 2005)

These pages of the report should be removed and replaced with the final version of the CBS Sub-group comments completed on August 25, 2005. The version contained in this draft of the report was a preliminary document.

MCA Response:

Adopted

U.S. Comment:

p. 1035, Flash Airlines 737 SU-ZCF Thread Diagram

The note at the bottom of the page states, "All possible scenarios being considered to explain the accident can be represented as a path from left to right through this diagram."

This comment highlights the need for a chronologically complete explanation for the accident flight, as agreed to by the investigative team. The possible causes by the draft final report do not satisfy this methodology.

U.S. Comment:

p. 1038, 9.0 Aileron Motion (Right Roll)

The statement "Need to Revisit" under the title on this page should be resolved.

The following comments are provided regarding statements under the columns for "Pros" and "Cons" about the possible similarity of the aileron movements recorded on the FDR to that associated with autopilot behavior and also about the statements "(there was no consensus on this point)."

The aileron motions around the FDR time 92414 (while the autopilot was briefly engaged in CWS-R) was specifically examined by the investigative team to determine if the

aileron deflection resulted from a manual (pilot) input or was commanded by the aileron autopilot system. The analysis included comparison of the aileron deflection (magnitude and duration) with previous manual and autopilot movements of the ailerons. The results of the analysis indicate that the deflection of the ailerons around the FDR time of 92414 was consistent with manual input.

Furthermore, two computer simulations were conducted to analyze how the autopilot would command the ailerons. Neither of these simulations showed aileron motions that closely matched the aileron deflections at time 92414.

The Egyptian team did not agree with either of these points.

U.S. Comment:

p. 1042, 13.0 Overbank (2 of 2)

The four statements on this page that "MCA requests that simulation be redone at point on maximum wheel deflection" should be deleted. These simulations were performed and the results provided to the MCA.

Furthermore, the results of the simulations for these hypothetical scenarios showed that the ailerons can still be controlled via the captain's control wheel. High control wheel forces would be involved in moving the control wheel, and M-cab simulations for control wheel forces of this level showed that the effects on speech would be noticeable and audible on the CVR. The accident airplane's CVR contained no such effects.

U.S. Comment:

Page 1044, Section 2.6.7 Thread Overview Updates Cairo 26-Aug-OS, Flash Air CBS Sub-group Comments (24 August 2005)

The section states, in part:

> The study performed by a team of qualified Human Performance Specialists have come up with findings summerized [sic] as follows:

This statement needs to be clarified. It should identify which of the preceding pages contain the material referred to as the study performed by the human performance specialists.

The second bullet on this page states:

> - There are conflicting signals in the following period of time (-17 seconds), it is unclear whether the captain remained in SD or was the crew unable to perceive the cause that was creating an upset condition until the time when the F/0 announced that there was no A/P in action.

This bullet should be revised to be consistent with the 25 Aug 2005 CBS comments, which were not included in the draft final report. These comments proposed that the captain was transitioning to type II spatial disorientation after his statement "How turning right." In light of the full range of evidence now available, which does not support the presence of a lateral control system malfunction, spatial disorientation is the most likely explanation for the captain's continued inappropriate control wheel inputs, which persisted for at least 17 seconds after that statement.

U.S. Comment:

Page 1045, Section 3 Conclusion, Summary

The first item under "General Background" states that "the A/C was serviceable at take off and was operated within the approved limitations."

The lack of write-ups on the slat and TOGA anomalies, which resulted in operation of the aircraft outside MEL limitations, makes this statement questionable. However, neither of these two conditions appeared to have any effect on the accident sequence.

U.S. Comment:

Page 1045, Section 3 Conclusion

This section states, in part:

> The crew members held appropriate licenses and were qualified for this flight.

This conclusion should be revised to address questions regarding the crewmembers' training. As stated earlier in these comments, the investigation did not adequately document whether the captain had fulfilled all of the training requirements for his position, as required under Egyptian Civil Aviation Regulations. The MCA was unable to produce documentation verifying the captain's completion of the required number of hours of ground instruction and company indoctrination training. In addition, it is unclear whether the ECAA had approved Flash Airlines' use of the Royal Air Maroc simulator for the captain's flight training. Finally, neither pilot had received CRM training, as stipulated in Flash Airline's ECAA-approved training manual.

MCA Response:

The Egyptian investigation team has reviewed all pertinent documentations with regard to pilot's training and qualification and is satisfied that the ECAA issued licenses are in accordance with local and ICAO requirements and all documents are included in this report.

U.S. Comment:

Page 1045, Section 1.1, Simulation Procedure

Statements in this section improperly cast doubt on the availability of control wheel data. Although the control wheel data recorded on the FDR was erroneous, accurate control wheel data was available from the M-cab. This section should also note that the motion of the airplane is consistent with recorded motion of control surfaces.

This section also appears to cast doubt on the M-Cab tests. As previously commented, the simulations (including M-Cab) were demonstrated to accurately model the behavior of the airplane for the purposes of the investigation.

U.S. Comment:

Page 1047, Section 2.2 Crew behavior

This section states:

> Evidence of distraction possibly becoming spatial disorientation is observed from the time of start of right turn until the announcement of aircraft turning right, after which it is unclear whether the captain recovered or remained in the the [sic] state of spatial disorientation. After the call "No autopilot commander", the crew behavior appears normal.

As stated earlier in these comments, the full range of evidence collected during the investigation indicates that the captain remained spatially disoriented at least until the recovery attempt began. Because there is inadequate evidence to make a definitive conclusion regarding which crewmember initiated the attempted recovery maneuver, it is not possible to determine whether the captain had reacquired an accurate sense of spatial orientation by that time.

U.S. Comment:

Page 1048, Section 3.5 Roll back towards wing level

This section states, in part:

> The following conditions could not be ruled out:

- Rudder surface position6 (Adopted)
- Pilot widening departure pattern (intentional control action)
- To level wings prior to engaging autopilot (intentionally)
- Pilot loses awareness of heading or bank (unintentional)
- Anomalies with the lateral control system

The investigation could not determine a higher possibility to any of the above findings based on the given data

As previously stated, the investigation ruled out any involvement by the rudder in the accident.

Although the second and third bullets could not be ruled out, the mostly likely cause is that the "pilot loses awareness of heading or bank."

It is suggested that a new section for "pitch up and airspeed decay" should follow this one and cite distraction as a likely reason for these deviations from target parameters.

U.S. Comment:

Page 1049, section 3.9 Aileron move in direction of right roll.

This section states:

- Rudder surface position (See footnote # 6) (Adopted)
- Pilot input
- Lateral system fault:

The investigation could not determine a higher possibility to any of the above findings based on the given data.

The rudder and rudder control system can be ruled out. During the multi-national investigative team's work, the rudder was ruled out as a possible contributor to the accident.

There is also no evidence of a lateral control system fault, and it should therefore be ruled out. The only remaining possibility for this section is "pilot input."

U.S. Comment:

Page 1049, section 3.10, Autopilot Disengagement indications on the FDR and CVR.

This section states that the investigation could not determine a higher possibility to whether the autopilot was manually or automatically disengaged.

If the flight control computers (FCCs) detect an invalid input from any autopilot system sensor during the autopilot engagement sequence, the engagement sequence will stop and an automatic disconnect occurs. The minimum time for an automatic autopilot disconnect

is 3.695 seconds. It is known from analysis of the accident airplane's FDR data that the autopilot was engaged a maximum of 3.6 seconds, and most likely less than this. Therefore, since the engagement time indicated on the FDR is less than the minimum

time required for an automatic autopilot disconnect, it can be concluded that the autopilot was manually disengaged.

U.S. Comment:

Page 1049-1050, Section 3.11 Airplane begins roll to right

The investigative team has already ruled out the rudder and the rudder control system, and the report should reflect this point. There is also no evidence of an autopilot or lateral system fault, and they do not prevent controlling airplane to the desired flight path.

In addition, this section currently contains no conclusion. It should indicate which of the possible explanations is most likely. Manual pilot inputs resulting from the captain's unrecognized spatial disorientation best explain the airplane's entry into a right bank.

U.S. Comment:

Page 1050, Section 3.13 Right roll continues to overbank with ailerons activities

The report states that the conditions listed in this section could not be ruled out and that the investigation could not determine a higher possibility to any of the conditions based on the given data.

The investigative team has already ruled out the rudder and an erroneous EADI, and the report should reflect these points.

Conditions related to an autopilot or lateral control system faults are not supported by the data. There is no evidence that these faults occurred, and they do not prevent controlling airplane to the desired flight path.

The captain's continued spatial disorientation is the most likely explanation for his continued inappropriate control wheel inputs during this period.

U.S. Comment:

Pages 1050-1051, Section 3.14 Flight crew CVR autopilot announcements

This section states, in part:

> The investigation could not determine a higher possibility to any of the above conditions based on the given data.

As previously provided for Section 2.5.14, Flight crew CVR autopilot announcements, the meaning of the flight crew's statements regarding the autopilot during this period are unambiguous. The captain's "autopilot" statements are consistent with requests for autopilot engagement. The first officer's statement, "Autopilot in command" is consistent with a rote response following a press of the command button. The first officer's statement, "No autopilot commander" was an attempt to communicate to the captain that the attempt to engage the autopilot was unsuccessful.

U.S. Comment:

Pages 1051, Section 3.15 Rapid left roll towards wings level

This section states, in part:

> From the above, Captain Upset Recovery Attempt seems a higher possibility

This conclusion is unsupported. There is insufficient evidence to conclude which pilot made the recovery attempt.

U.S. Comment:

Page 1051, Section 3.16 Impact with water

This section states, in part:

> Although an attempt to correctly recover was initiated, the gravity of the upset condition with regards to attitude, altitude and speed made this attempt insufficient to achieve a successful recovery.

This section should clearly state that although the airplane remained responsive and controllable through out the entire flight, the overbank recovery attempt was begun too late to prevent impact with the ocean.

p. 1052, Findings, 3.1 Possible Causes

The draft final report provides the following as possible causes:

- Trim/ Feel Unit Fault (Aileron Trim Runaway)
- Temporarily, Spoiler wing cable jam (Spoiler offset of the neutral position)
- Temporarily, F/0 wheel jam (spoilers offset of the neutral position)
- Autopilot Actuator Hardover Fault
- A distraction developing to Spatial Disorientation (SD) until the time the F/0 announced "A/C turning right" with acknowledgement of the captain.

As stated in the U.S. team's cover letter to these comments, the only scenario that satisfies the logic and methodologies adopted by the investigative team is the one involving spatial disorientation. The remaining possible causes are not consistent with and would not lead to the sequence of events identified by the investigation.

Because the draft final report does not provide evidence or justification to conclude that the first four possible causes listed above may have occurred, these "possible causes" should be removed.

U.S. Comment:

Page 1052, Findings

The draft final report properly notes that the path of the airplane was consistent with the recorded motion of the control surfaces. This should be added as a finding in this section.

U.S. Comment:

p. 1053, Conclusion

The evidence and the analysis methodology agreed to and adopted by the full investigative team supports only a conclusion of spatial disorientation by the captain. The first officer's failure to assume timely control of the airplane should also be identified.

U.S. Comment:

p. 1054, Recommendations

Justification for recommendations 1 through 4 is unclear.

Regarding recommendation 3, it should be noted that there was no evidence the crew misunderstood the engagement status.

Regarding recommendation 4, it should be noted that the U.S. Federal Aviation Administration initiated an independent re-examination of the B-737 autopilot system early in the investigation. The FAA's review concluded that no safety action was required on the B-737 autopilot/flight director or attitude display systems. The results of this review were provided to the MCA on 13 December 2004.

Regarding recommendations 6 and 7, Industry developed "Airplane Upset Recovery Training" is currently available. These recommendations should be addressed to either operators for incorporation in training programs or to the CAA for regulatory action.

Regarding recommendation 8, it should be noted that spatial disorientation is a well-documented phenomenon. It would be more appropriate to recommend awareness training for crews. This recommendation should be addressed to a specific organization.

Regarding recommendation 9, it should be noted that the CRM failings in this accident included a lack of assertiveness on the part of the first officer. This aspect should be better addressed in both operating procedures and CRM training. This recommendation should be addressed to either operators for incorporation in training programs or to the CAA for regulatory action.

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Ministère des Transports,
de l'Equipement,
du Tourisme et de la Mer

BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Le Bourget, 2 January 2006

Captain Shaker Kelada
Commission of Inquiry into accident at
Sharm el-Sheikh
Ministry of Civil Aviation
Airport Road P.O. Box 52
Heliolpolis, Cairo
Egypt

N° 000001 /BEA/D

Subject: Draft Final Report - Comments
Your Ref: Flash airlines flight 604, 3 January 2004
Attachment : -

Dear Captain Kelada,

Thank you for having associated the BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'Aviation Civile) with the investigation into the accident to the Boeing 737-300, registered SU-ZCF, and for the opportunity to make comments on the Draft Final Report. I would also like to reiterate our great appreciation for the spirit of cooperation that has permeated this investigation and for your consideration for the suffering of the families of the victims of the disaster.

It is in this same spirit, and with the interests of civil aviation safety in mind, that we hereby present you with the following observations. I hope that they will appear to you to improve the overall comprehension of the accident and that you will accept that they be included into your report. If this is not the case, I would be obliged if you would append this letter to the report, in accordance with the provisions of Annex 13.

Part 1 (Factual Information)

The factual part of the report contains a certain number of errors and omissions that were identified in the course of the investigation. The BEA draws your attention to these points, and in particular that:

- There are erroneous values in the parameters in section 1.1 (History of Flight);
- Details of Flash Airlines pilots' flying activity were supplied during the investigation. They should be appended to the report. These details modify the information included on page 48-1;

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- The CVR transcript does not take into account the additional information brought to light after further listening last August;
- The reports on the simulations undertaken in Seattle in October 2004 are not appended to the report;
- On several occasions, information supplied by the manufacturer is replaced by a note relating to proprietary information. It appears that the manufacturer does not, however, consider its explanations to be confidential. Consequently, the technical data that had previously been reserved should be included in the report.

Part 2 (Analysis)

- On the basis of the analysis, the report accepts four possible technical failures. It should be noted that the extensive group work made it possible to eliminate the numerous cases examined, with the exception of two (Aileron trim runaway, Autopilot actuator hardover). Concerning these two hypotheses that were not eliminated, simulations undertaken showed that the crew would still have been able to control the airplane's track.

- An additional hypothesis implicating the rudder, which was never discussed during the group work, appears in the analysis. Examination of the factual elements supplied confirms that this hypothesis is not relevant in the context of the accident.

- The operational aspects, including those possibly related to the technical points raised, are not developed. It is, however, internationally recognised that examination of these elements is important and unavoidable in an aircraft accident report. It is necessary to examine why the crew, when confronted with an abnormal and unusual situation, did not seem to have either analyzed this situation or to have mobilized all of its available resources to deal with it. The CVR readout shows an absence of appropriate dialogue aimed at identifying a possible problem or proposing a solution to it.

- Cockpit Resource Management (CRM) training was not mandatory in Egypt at the time of the accident. The operator, in contradiction with the specific part in its Operations Manual and with the response given following the audit performed in January 2003 by the ECAA, had not set up such a training programme. It should also be noted that some other remarks made in the course of the audit were not in effect taken into account (notably in relation to recruitment of additional pilots and to follow-up on daily maintenance).

- In the analysis, it is necessary to examine the knowledge that the Captain possessed to enable him to identify and manage the crisis situation encountered during this flight, which implies studying the successive training programmes that he had followed. His activity for several years showed no evidence of any structured training in this area, nor more generally for the role of Captain. Thus, it seems that his initial conversion on ATR 42, along with the validation by equivalence of his Captain's license, corresponded neither to generally accepted qualification standards nor to Egyptian regulations. On the technical level, his type rating had been carried out on 737-500 and not on 737-300, without any training on the specificities of the fleet's airplane's (variant training) being included in the operator's documentation.

- Study of the « Human Factors », which is included in section 2.6, is based on documents supplied during the first meeting of the sub-group (August 2004).

Further work, undertaken with the assistance of American and French specialists for a second meeting of the sub-group (August 2005), is appended to the section but not developed. This work brought to light evidence of two probable phenomena, spatial disorientation and fatigue. Examination of these phenomena should be detailed and structured because of their importance both for an understanding of what did, or did not, happen during the flight as well as for safety in air transport. In fact, these physiological phenomena are of a type that may affect any pilot, whatever his or her experience, skills or state of health might be.

- In relation to fatigue in particular, it appears, according to documents supplied by the ECAA (regulations and crew service schedules) that the operator's management of the crew 's periods of activity was not in accordance with the national regulations.

Part 3 (Conclusions)

Bearing in mind the preceding, the BEA proposes the following modifications to the Findings and Conclusion.

- Section 3.1 (Possible causes): eliminate the two causes that were proved not to have contributed to the accident (bullets two and three).

- Section 3.2 (Possible contributing factors): add four factors

- Resources mobilised by the crew were not appropriate to the emergency situation encountered.
- Neither pilot had followed Cockpit Resource Management (CRM) training courses, noting that such training was not mandatory in Egypt at the time of the accident.
- The Captain had not followed a structured training programme for the role of Captain of a civil transport airplane.
- Taking into account his activity in the previous days, the Captain was very probably suffering from sleep deficit.

- Section 3.3 (Additional findings): add one factor

- At the time of the accident, the operator had not yet implemented various measures decided on following an audit carried out in January 2003.

- Concluding section: add, to the end of the last sentence of the first section, « while noting that the airplane remained controllable throughout the flight ».

The BEA remains at your disposal for any further information that you may wish to obtain.

Yours sincerely.

Le directeur du BEA

P.L. ARSLANIAN

MCA Response:

Part 1 (Factual Information) adopted

Part 2 (Analysis): Hypothesis implicating the rudder adopted

FLASH AIRLINES

ملف حادث فلاش اعلى ٦/١/٩

Member of FLASH GROUP

5th January 2006

Dear Captain Shaker

Comments of Flash Airlines upon draft final report into the loss of Flash Airlines Flight 604

Please find attached our comments upon the draft final report into the loss of Flash Airlines Flight 604 on 3 January 2004. We should be grateful if you and your Accident Investigation Team would consider our comments forthwith and let us know whether, in the light of these comments, you are prepared to amend the draft final report to reflect them. In the event that any of the attached comments are not reflected in amendments to the draft final report, we should be grateful if you would append a copy of the relevant comments to the final report.

Kind regards

Yours sincerely

Mohamed Nour
Chairman & CEO

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Comments of Flash Airlines upon the Draft Final Report into the loss of Flash Airlines Flight 604

Flash Airlines welcomes the opportunity to comment upon the draft Final Report of the Accident Investigation into the loss of Flash Airlines Flight 604 on 3 January 2004. Our comments are set out below. It should be noted that these comments reflect our analysis of the draft report within the limited time (60 days) and with the resources available to us following release of the draft to interested parties. They do not therefore necessarily represent Flash's final view on every issue and Flash's position is reserved generally in that regard.

Spatial Disorientation

1. Flash does not accept the existence of any spatial disorientation ("SD") on the part of the flight crew, or that it is appropriate for the report to make any finding to that effect, in the absence of unequivocal and positive indicators of its presence. It follows from the analysis in 4-6 below that some other explanation must in any event be sought for the behaviour of the aircraft after the limited window referred to in those paragraphs and during the most critical phase of the flight. That being the case, it is inappropriate and unnecessary to speculate as to the existence of SD during any earlier phase of the flight, unless there is clear evidence of its existence.

2. The report's analysis of the possible existence of SD on the part of the Captain is, in any event, confusing. In particular, it is frequently unclear what sections of the report concerning this issue represent the views of the investigation team itself and what represent submissions made to it by others.

3. The key part of any such analysis must be to test the possible existence of SD at various stages of the flight against the CVR transcript evidence of the recorded remarks of the Captain and the information he was being given by the First Officer. The investigation team's views on, and the conclusions they draw (and why) from, each stage of this process should be clearly set out.

4. If one carries out the exercise referred to in 3 above, this supports the view that, even if there was any SD present on the part of the Captain at any stage of the flight, it had ended before the aircraft's roll to the right resulted in an overbank and long before the point at which, if the aircraft had been performing normally, the manoeuvre ceased to be easily recoverable by the flight crew. In particular, at 02:44:31 the First Officer stated "*Aircraft is turning right*". At 02:44:37 the Captain responded to this by saying "*How turning right?*" and at 02:44:41 (when the aircraft's bank angle was approximately 40°) "*OK come out*". At that time the ailerons are returned to beyond neutral, the high right roll rate stops and a momentary left roll rate occurs (quoting from the Factual Report). This demonstrates that, by this time at the latest, the Captain had assimilated the information he had been given by the First Officer and reacted correctly to it. At this stage, therefore, there can be no question that the Captain appreciated the aircraft's rolling movement and furthermore knew his right from his left in terms of inputs to the flight controls. Any SD on his part was, on the available evidence, over by this time.

5. The draft report appears to regard the movement of the ailerons recorded at 92393 (02:43:39) as the beginning of a right roll manoeuvre that continued until the aircraft recovery attempt began (see 2-5-9, page 4). This is incorrect. This was in fact the start of the aircraft rolling out onto the 140°M heading, where it then remained for approximately 9 seconds. This appears to have been a deliberate (and accurately flown) manoeuvre on the part of the Captain. There is no evidence of SD at this point. The critical roll to the right only commenced with the aileron movement seen at 92420 (02:44:06) or 92421 (02:44:07), some 4 or 5 seconds after disengagement of the autopilot.

6. The conclusion to be drawn from 4 and 5 above is that, even if there was any SD on the part of the Captain, it was relatively short lived and in any event ended before the aircraft's attitude became critical. In these circumstances, it is inappropriate for the Report to include SD as a possible cause of the accident (see "FINDINGS" at 3.1). At most (and subject to the comments made in 1 above), SD should be included as a possible contributing factor only.

7. Any analysis of the issue of SD should also consider what event might have triggered it (if it existed at all) and whether a failure or malfunction of any of the aircraft's systems are likely to be implicated in that.

Autopilot disengagement

8. The potential significance of the autopilot disengagement has been obscured within the weight of detail contained within the draft report. This event occurs (at FDR frame 92416 or 02:44:02) only 4 or 5 seconds before the aircraft commences the critical roll to the right. Is this just a coincidence? It is important to bear in mind that Boeing's/Honeywell's analysis of the possible reasons for the disengagement is entirely predicated on the assumption that the unit was in this regard performing as designed: ie that it would only have automatically disengaged for a reason anticipated in its design. (Indeed this assumption effectively underlies all of the aircraft system fault tree analyses included within the draft report.) An alternative approach is to treat the disengagement as an indicator of a possible problem with the aircraft's systems (and potentially one still undiagnosed). If that is the case, then one cannot rule out the possibility that the autopilot disconnected for a reason not yet analysed by Boeing/Honeywell. It also invests the closeness in timing between this event and the start of the right roll with potentially far more significance than presently appears from the draft report.

9. Even on the basis of Boeing's/Honeywell's own analysis, another reason should be added at 3.10 of the Conclusions as a possible reason for the autopilot disengagement: namely failure of the unit to synchronise and pressurise following engagement (see section 2-5-10, page 5, of the draft report).

Flight Director commands to the flight crew

10. The draft report rules out the possibility of erroneous Flight Director ("FD") commands to the flight crew, apparently on the basis of a Honeywell presentation to the effect that it is not possible to have valid FDR data with erroneous commands (see

for instance 2-5-11, page 4, footnote 1). However, the implicit assumption that all FCC FDR data is valid appears to be incorrect.

11. In particular, the FDR records show anomalous readings for the SEL COURSE 1 and SEL HEADING FCC L settings interspersed between what appear to be true readings. On the SEL COURSE 1 parameter, the FDR records show readings of 306.035 (assumed to be a correct reading as a course setting of 306 would coincide with the VOR radial to be flown from Sharm el-Sheikh) interspersed with readings of 359.912. Similarly on the SEL HEADING FCC L parameter, the FDR records show readings of 219.814 (the runway heading) and later 106.875 (again assumed to be valid readings) interspersed again with readings of 359.912.

12. Boeing have described one of the anomalous SEL HEADING FCC L readings as "apparent data drop out" (see the comments on the graph at paragraph 1.16.1.2, page 163-1 of the draft report) and seemingly ignored both the other anomalous SEL HEADING FCC L readings and the anomalous SEL COURSE 1 readings. However, "data drop out" is a very unlikely explanation, given that the anomaly has affected only these parameters. It should be noted that, on a 12 digit binary readout for the range between 0° and 360°, 359.912 corresponds to "111111111111". These anomalous readings are positive evidence of a fault, which is unlikely to have been in the FDR. It is more probable that there was a fault in either the left FCC or in the MCP (Mode Control Panel). It is difficult in these circumstances to understand how the report can rule out the possibility that the FD was issuing erroneous roll commands to the flight crew. An erroneous roll command might well explain the commencement of the roll to the right following autopilot disengagement. Further, even if there was some SD present on the part of the Captain during the early part of that manoeuvre (in which regard see 1-6 above), it might help to explain what triggered this, particularly if the Captain was also receiving confusing displays on his EHSI (Electronic Horizontal Situation Indicator) due to a similar problem with Course Select. The report should analyse this whole issue.

Possible rudder defect

13. There is no real analysis within the draft report of the potential role played by a rudder defect in explaining the accident and this issue deserves more attention in the final report. The draft report expressly does not rule this out as a possible factor. That being the case, and bearing in mind the part played by the B737 rudder in previous similar accidents, it is difficult to understand why a rudder defect is not listed within the possible causes at paragraph 3.1 of the Findings.

Master Caution

14. The significance of the Master Caution being triggered twice during the flight (the first during taxi, the second towards the end of the flight) deserves more attention and analysis. The first occurred during the pre-flight rudder control check. Is this just a coincidence? The second should be analysed as possible evidence of a systems failure on the aircraft.

Autopilot Actuator Fault

15. The draft report analyses at section 2-5-13, paragraph 6.2.2.3.1, a possible autopilot actuator fault, which it concludes shows close consistency with the event. The report states that this condition requires 3 concurrent faults, one of which could have been latent generally and a second of which could have been latent from any time after the last use of the autopilot on a previous flight. It fails however to emphasise sufficiently that they also could all be triggered by an electrical short within the electrical socket on the autopilot actuator and could therefore have a single, common, cause.

Aileron Trim Runaway

16. The draft report also analyses an aileron trim runaway and concludes that it cannot be ruled out as a possible condition and shows close consistency with the event. This systems failure required only two concurrent faults, one of which could have been latent. One feature of such a failure that the report does not draw adequate attention to is the fact that a trim runaway would take some time to produce full aileron deflection and would therefore produce a roll which gradually deteriorated into an overbank (the same situation as occurred in this case).

Recorded aileron movements

17. The report notes that, even during the attempted recovery phase at the end of the flight, aileron action is recorded in both directions. The potential importance of this finding is not explored in the draft report. Yet it would seem to be evidence of the pilot in command fighting some countervailing force during this period. Similar indications can be found earlier at FDR frame 92432 (02:44:18), when the Captain said *"See what the aircraft did"* (aileron movement for one or two seconds asking for left roll, presumably in response to the aircraft movement which provoked the Captain's comment, followed by aileron movements commanding right wing down), and at FDR frame 92453 (02:44:39), just before the Captain said *"OK come out"* (large aileron movement asking for left wing down, producing the momentary left roll noted in the Factual Report, followed by more right wing down aileron movements). These readings suggest deliberate left wing down inputs by the Captain (coinciding with consistent statements on the CVR record), followed by a resumption of right roll commands as soon as he relaxes on the control wheel. This is very significant evidence of the possible existence of some form of systems failure or malfunction.

No reliable control wheel FDR data

18. It seems remarkable that the only parameter on which there is no reliable recorded data on the FDR is the control wheel position. Is it possible that the condition which led to the control wheel sensors producing anomalous results also affected the functioning of the control wheels themselves?

Draft Findings

19. At paragraph 3.2 of the Findings, the first two items (tech log copies left on board; write up of defects) should be removed from the possible contributory factors.

Whatever the position may have been regarding these matters (as to which Flash expressly reserves its position), there is no evidence that these matters had anything whatsoever to do with the accident.

20. Even leaving to one side the point made in 1 above, we do not consider it appropriate for the remaining two items of paragraph 3.2 to be included as possible contributing factors. If they are to appear anywhere, they should appear elsewhere within the report since (as currently drafted) they are simply part of the report's analysis.

General

21. It is inappropriate for the final report to contain blank pages due to Boeing's refusal to release proprietary data. If the information which would have been included there is relevant to the report's findings, it should be set out or summarised and interested parties should be given a further opportunity to comment before a final report containing such data is released.

22. Both paragraphs 1.5.1.6 and 1.5.2.6 of the draft report state that "no official head of operation in Flash Airlines" was (apparently) available for interview during the investigation. On a point of information, the company's Operations Manager on the date of the accident was Ihab El Sonbaty, who was one of the off duty crew members killed in the accident.

In the event that any of the above comments are not reflected in amendments to the draft Final Report, we should be grateful if you would append a copy of the relevant comments to the Final Report.

MCA Response:

Spatial Disorientation comment adopted

Arab Republic Of Egypt
Ministry Of Civil Aviation
Egyptian Civil Aviation Authority

جمهورية مصر العربية
وزارة الطيران المدني
سلطة الطيران المدني المصري

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Submission by Egyptain Civil Aviation Authority to the draft report of the Flash Airlines accident investigation

Dear Captain Kelada

The ECAA being a party to this investigation thank the investigation committee for their effort and the chance to give our comments on the draft report.

Having participated in the different groups of the investigation we are comfortable with the findings that have been offered in general, nevertheless we would like to make one comment that has come out of the Crew Behavior Subcommittee.

The ECAA studies are in agreement with the draft report that the Captain was temporary distracted and may have developed to temporary spatial disorientation having said that it is apparent this state is a consequent result of a previous action.

Based on these facts the phase of distraction and spatial disorientation was a reaction to some previous happening and therefore this finding could have only contributed to the accident.

The ECAA requests the finding of the crew behavior's distractions and possible spatial disorientation be considered a possible contribution factor.
We would appreciate the above to either be amended or appended in the final report

Best Regards

Pilot / Samir Abdel-Maboud Abdel-Aziz
Samir A Maboud
Head of,
Egyptian Civil Aviation Authority

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MCA Response:

Comment adopted