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

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.

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

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.

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.

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.

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/O began his ground training on the aircraft type 737-300 at Luxor Airway from 4 May 2002 to 16 May 2002
- The F/O 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.

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.

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

This section refers the reader to pages 72 and 73 of the factual report for information on the F/O'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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

Page 267, Section 1.16.1.10. Boeing response to raised questions.doc
"Answers to question_cairo 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.

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.

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.

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.

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.

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.

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.

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.

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 IIIJ 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.

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.

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.

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.

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.

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.

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.

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.

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.

Page 338, 1.18. Additional Information

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 administrive [sic] post (Chief of Staff of an Airforce base) with no flying duties.

Page 354, Section 7.3 Last PDC Carried out for the Accident Flight

see comments provided for p. 120, Section 1.6.6.3

Page 356:

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

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.

ANALYSIS

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.”

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.

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.

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.

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.”

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

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 on 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.”

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.

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.

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

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).

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.

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.

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.

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.

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.

Page 850, Section 6.1.1.4 Pilot Loses Situational Awareness

The subsection on this page titled “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.

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 lb 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.

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.

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.

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

This section states:

> 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.

Page 894, 6.3.5.3.2 Scenario 10a - F/O wheel jam (F/O 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 lbs 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 lbs 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 lbs 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 lbs 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.

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.

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."

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/O 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.

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.

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.

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.

p. 962, I- 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 1800 ft/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 S1 closed contacts resulted in the FCC intermittently detecting the S1 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. Boeing has received no further reports of this condition.

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.

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.

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.

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.

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.

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.

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.”

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.

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.

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.

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.

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 l---- 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.

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."

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

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.

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.

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.

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.

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.

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.

Page 1044, Section 2.6.7 Thread Overview Updates Cairo 26-Aug-05, 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/O 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.

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.

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.

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.

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.

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
- 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.

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

This section states:

- Rudder surface position (See footnote # 6)
- 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."

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.

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.

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.

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.

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.

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/O wheel jam (spoilers offset of the neutral position)
- Autopilot Actuator Hardover Fault
- A distraction developing to Spatial Disorientation (SD) until the time the F/O 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.

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.

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.

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.