Letter of transmittal from Captain Mohsen El Missiry, dated September 13, 2000, and attachment: EgyptAir's submission to the National Transportation Safety Board's public docket of the investigation of the crash of EgyptAir flight 990 on October 31, 1999

16 pages

September 13, 2000

Mr. Gregory Phillips
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

Dear Mr. Phillips,

The Egyptian Civil Aviation Authority requests and authorizes you to place the EgyptAir submission dated August 11, 2000, into the public docket for the EgyptAir flight 990 investigation.

Sincerely,

[redacted]

Captain Mohsen El Missiry
Chief of Egyptian Investigation Committee

(1)

مصر للطيران
EGYPTAIR

August 11, 2000

Mr. Greg Philips
National Transportation Safety Board
490 L'Enfant Plaza, S.W.
Washington, D. C. 20594-0003

Dear Mr. Philips

Please find attached herewith, EgyptAir submission required to be included in the docket of EgyptAir FLT 990 accident investigation

Sincerely,

[redacted]

Captain Shaker Kelada
V.P. Safety and Quality Assurance
Lead Investigator
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(2)

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EGYPTAIR'S SUBMISSION TO THE NATIONAL TRANSPORTATION SAFETY BOARD'S PUBLIC DOCKET OF THE INVESTIGATION OF THE CRASH OF EGYPTAIR FLIGHT 990 ON OCTOBER 31, 1999

EgyptAir, a party to the investigation into the cause of the crash of EgyptAir Flight 990 on October 31, 1999, provides the following analysis of the available evidence collected thus far during the investigation, including factual data gathered by the National Transportation Safety Board ("NTSB") working groups and the Egyptian investigation team. Although the investigation is not yet complete, certain conclusions can be drawn.

- An analysis of the facts and of the elevator control system's design indicates that malfunctions in two power control actuators (PCAs) on the right elevator may have precipitated the airplane's dive. This dual PCA malfunction may have consisted of a latent or nearly latent, failure in one PCA that may have existed for an extended period of time followed by a jam of a second PCA shortly before the dive.
- The facts do not support the initial, and widely reported, theory that the first officer deliberately dove the plane toward the ocean.
- Without further information concerning the data from military and FAA radar, one cannot rule out the possibility that the first officer may have been attempting to avoid or maneuver the aircraft out of a perceived dangerous situation at the time the dive occurred.

Accident Background and Investigation Status

EgyptAir Flight 990, a Boeing 767-300, bound for Cairo crashed into the Atlantic Ocean shortly after takeoff from John F. Kennedy International Airport, New York, on October 31, 1999. The aircraft impacted the ocean at approximately 0150 EST, 60 miles off the coast of Massachusetts. All 217 passengers and crew perished.

Shortly after being notified of the crash, NTSB Board Chairman Jim Hall contacted the Egyptian Civil Aviation Authority ("ECAA") to seek authority to conduct the investigation on behalf of the Egyptian government. Pursuant to Annex 13 to the Convention on International Civil Aviation, the Egyptian government delegated authority for the management of the investigation to the NTSB. EgyptAir was provided party status pursuant to the Convention.

The ECAA and EgyptAir dispatched a number of investigators to participate in all aspects of the investigation. Since last November, these investigators have resided in Washington, D.C., gathering and analyzing the evidence. Additional experts, including interpreters, religious authorities, metallurgists, engineers and aerodynamicists have also been called upon to assist in the investigation. Today, additional aircraft performance data and additional radar information is needed before the NTSB's factual investigation can be closed and the true cause of this tragic accident determined. One thing is certain, though - the evidence gathered in this investigation does not support the conclusion that the first officer deliberately dove the aircraft into the ocean. To the contrary, the factual evidence indicates that an elevator control malfunction may have occurred causing the crash.

1. Evidence Developed During the Investigation Indicates that Malfunctions in Two Power Control Actuators May Have Precipitated the Airplane's Dive

Each elevator surface on the Boeing 767-300 is hydraulically powered by three actuators. If one actuator valve is restricted (jammed) at an offset position in the down direction, then the remaining two actuators will continue to operate the elevator. However, unlike the design of the Airbus, there is no aural warning or visual indication in the cockpit, alerting the crew of a

malfunction in the elevator system. Further, there is no other clear means for the flight crew to physically determine from the cockpit that an actuator has jammed or malfunctioned.

With a single failure and with the autopilot disengaged, an induced force of 15 pounds is fed back to the control columns resulting in a slight forward movement of the control columns and a slight downward movement of both elevators. These deflections would probably not be noticeable to the crew during normal operation of the airplane. With the autopilot engaged, this failure is latent. Nothing will be observed in the cockpit.

With another PCA valve jam failure on the same side, the affected elevator will move uncommanded to the maximum down position for the existing flight conditions with no further control available from either control column. This elevator movement will only be affected by airplane speed and attitude. The unaffected elevator will follow the affected side. Again, no visual or aural warning to the flight crew is associated with this failure. The elevator deflections described in this scenario are consistent with the elevators' behavior during the accident sequence.

Over the past five years, there have been a number of reports of bellcrank rivet shears in the Boeing 767 actuator bellcranks which are designed to occur as a result of a jam in the elevator control system. Until recently, the linkage shears were confined to a single bellcrank actuator.

In February 2000, however, during a preflight check on an AeroMexico Boeing 767 airline personnel noted that the elevator was drooping. Resulting inspection and examination of the elevator bellcrank linkages disclosed that two of the bellcranks on the same elevator side had sheared rivets. The airplane had flown for two weeks and about 77 hours since the actuators had been replaced. Apparently, since the replacement of the actuators, at least one of the bellcrank shears had occurred suddenly and without warning of impending failure.

On July 20, 2000, Boeing sent a letter to all 767 customers advising them of the possibility that the elevator single system hydraulic test Certified Maintenance Requirement may not detect a sheared bellcrank rivet and that the Federal Aviation Administration plans to release an Immediate Adoptive Airworthiness Directive concerning this issue. This validates the safety issues addressed by the Egyptian Civil Aviation Authority to the FAA in June 2000.

Only four of the six elevator actuators from Flight 990 have been recovered from the ocean. One actuator, identified as that from the right elevator outboard position, contained abnormalities when compared to the remaining three actuators recovered. These abnormalities include the following:

(a) the actuator's hydraulic piston found in a fully retracted position (airplane nose down) which is consistent with a jammed servo valve;

(b) an unusual separation of the spring guide in the servo valve commanding the piston. (Because of the orientation of the servo perpendicular to the direction of flight and the accelerations required to fail the connecting pin to the spring guide, the observed damage could not have been impact related.);

(c) overriding positioning of bias spring coils with respect to the spring guide; and

(d) particulates in the servo cap where the spring guide and spring coils are housed. In addition, examination of the bellcranks for this actuator and the adjacent middle actuator disclosed rivet shears that may be consistent with a jammed condition in the actuators combined with input forces to the control column trying to move the elevator to an airplane nose up position. All the remaining bellcranks recovered were found to have rivet shears in the opposite direction. One of these was from the adjacent right elevator inboard actuator linkage position that still had continuity of the input rod to the middle bellcrank.

It is known that jamming of an actuator can occur without leaving any direct evidence of a jam. Indeed, the NTSB has so concluded in at least two accidents involving Boeing aircraft-- USAir Flight 427 at Pittsburgh and United Airlines Flight 585 at Colorado Springs. Although no direct evidence of jamming has been disclosed in the actuators examined, the circumstantial evidence

indicates that such jamming may have occurred. Further, there are two remaining actuators for this accident airplane that remain unaccounted for. These actuators may reveal evidence of jamming or other unusual conditions.

If a dual servo actuator failure is assumed, the position of the elevator throughout the flight can be calculated using calibrated air speed and aircraft body angle. Using Boeing's published data for the 767,[1/] this calculated elevator angle is within one degree of the position recorded on the FDR. Taking into consideration the uncertainty of extrapolated data for aircraft speeds above Mach 0.91, the FDR data are consistent with a dual servo failure.

2. Boeing's Analysis of the Ground Tests and Flight Simulations is Flawed

Boeing agrees that a dual actuator failure can occur on the Boeing 767-300 aircraft under circumstances described in the preceding section. Boeing also agrees that such a failure scenario would cause the aircraft to dive downward with no warning to the pilots of the aircraft. However, Boeing's analysis of the ground tests and flight simulations is flawed for several reasons. (See Boeing's report which is the Systems Group Chairman's Factual Report Addendum Regarding the Dual Elevator Power Control Unit Failure Effects and subsequent amendments.)

First, the Boeing ground tests conducted this past Spring on an actual airplane showed significant differences between the actual behavior of the aircraft's flight control system and Boeing's own published data. Consequently, no valid conclusions can be drawn without reconciling the conflicts between the published data and the ground test data.

Second, the parameters for the Boeing flight simulator were again based upon the Boeing published data and, thus, as noted above, did not reflect the actual operation of the airplane. In

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[1/] Boeing does not have published data for aircraft speeds exceeding Mach 0.91.

addition, certain controls in the simulator, critical to the analysis of the elevator system, were not the same as on an actual airplane. For example, the captain and first officer control columns were rigidly connected and did not permit differential control column movement. As a result, the flight simulator did not accurately model the connection between the captain's and first officer's control columns. Because of these limitations, the testing cannot be used to prescribe how a Boeing 767 will react to a dual actuator malfunction.

Third, Boeing's analysis only considered steady state values from Boeing's published data to calculate forces on the control column in various flight conditions. Valid conclusions cannot be drawn from steady state values when analyzing a very dynamic situation such as this accident sequence.

Fourth, Flight 990 reached speeds of at least Mach 0.98 -- far in excess of Boeing's performance data which stops at Mach 0.91. Boeing's analysis, therefore, depends upon extrapolated Mach 0.91 data. Because aerodynamic forces change dramatically at speeds approaching Mach 1.0 -- the speed of sound -- the use of extrapolated data to analyze Flight 990 cannot produce accurate results. If the uncertainty of the extrapolated data for speeds above Mach 0.91 is taken into consideration, the FDR data is consistent with a dual actuator failure.

3. The Evidence Refutes the "Deliberate Act" or "Suicide Theory"

A. Creation of the "Deliberate Act" or "Suicide Theory"

Within two weeks following the crash, the flight data recorder (FDR) and the cockpit voice recorder (CVR) were recovered from the ocean floor and initially analyzed by the NTSB and other federal investigators. Based primarily on an inaccurate translation of the first officer's use of a Muslim phrase contained on the CVR and other out of context information selected from the FDR,

U.S. government sources "close to this investigation" theorized that the first officer, Gameel el Batouty, committed suicide by diving the aircraft into the ocean. Although no government official has stated that suicide was the cause of the crash, this theory was extensively reported by the U.S. media, primarily supported by leaks of out of context statements taken from the inaccurately translated CVR transcript.

When Chairman Hall announced that he had met with FBI Director Freeh and stated, "This accident might be the result of a deliberate act," the suicide speculation increased (statement by Chairman Hall, November 19, 1999). Consequently, less than three weeks following the crash and without recovering, much less examining, any significant portions of the wreckage, the unofficial cause of this crash was that it was the result of a deliberate act by the first officer. Now that the CVR has been accurately translated and the FDR has been thoroughly analyzed, there is no credible evidence supporting the theory that the first officer deliberately dove the aircraft toward the ocean. To the contrary, there is overwhelming evidence refuting it.

B. The First Officer Did Not Deliberately Act to Cause this Crash

The factual record developed after nine months of investigation conclusively refutes the initial deliberate act theory widely reported in the early days following the accident. Indeed, no credible facts have been produced to support this theory. The following sections discuss the evidence refuting the theory.

(1) The First Officer's Expression was not a "Prayer" and Does Not Support a Theory Based on Suicide or Deliberate Act

The deliberate act theory was based, in large part, on the initial inaccurate translation of an expression repeated several times by the first officer. This phrase was incorrectly translated as, "I place my fate in the hands of God." Once

knowledgeable interpreters were brought into the investigation to listen to the CVR recording, the phrase was properly translated as, "I rely on God," a common, every day, Muslim expression used by Egyptian Muslims and Christians throughout their day-to-day activities, and, particularly, when they are seeking God's support. It would not be used in conjunction with a suicidal or criminal act. The CVR Group Chairman's report reflects the accurate translation of the first officer's utterance. Religious authorities consulted also support this view. (See the CVR Group Chairman's report.) Consequently, the linchpin of the deliberate act theory has been eliminated not only by credible evidence and analysis but also by accurate translation of the CVR.

(2) The First Officer had No Motive to Kill Himself or Others Aboard Flight 990

The first officer's personal and professional life have been intensely investigated and scrutinized not only by the NTSB, but also by the FBI. No one has identified any motive for the first officer to kill himself and 216 other passengers and crew. No behavior before the flight has been identified that could in any way be linked to a suicidal effort. Indeed, friends who knew the first officer and saw him during the days before the accident reported that he was acting as he always did.

The first officer had no overriding personal, professional, medical or financial problems. To the contrary, he and his family were respected in his community. He was also looking forward to his son's upcoming wedding. And, although his daughter was being treated for lupus in Los Angeles, he was financially capable of paying for the relatively expensive treatment. Additionally, the first officer's medical history is completely devoid of any reference to a diagnosis or treatment for

any mental health problems, including depression. And finally, no psychiatrist or psychologist has provided any analysis supporting suicide.

Other facts inconsistent with that of a person contemplating suicide include the fact that he was bringing tires back to Egypt for his family and that the day before the flight, he offered Viagra to another EgyptAir pilot, but kept several for his own future use.

(3) The First Officer Did Not Use His Seniority to Insist that He be Allowed to Fly the Airplane

It has been erroneously reported in the media that the first officer used his seniority to take over the first officer flying duties so that he could position himself at the controls. Even a cursory review of the CVR transcript does not support this allegation.

EgyptAir did not have a formal policy regarding crewmember relief. A relief crewmember could be asked to fly at any time during a flight. In this instance, Gameel el Batouty discussed the fact that he could not sleep and offered to fly earlier than his scheduled rotation. The flying first officer agreed.

(4) Data Collected from the CVR and FDR Does Not Support the Suicide Theory.

The following additional facts from the CVR and FDR also refute the suicide theory:

(a) The CVR report raises the distinct possibility that the first officer was not alone in the cockpit at the onset of the dive. Four voices were identified on the CVR before the dive began and before the captain left the cockpit. Indeed, after the captain left the cockpit, the cockpit door was not closed, and other crew members were probably present or in close proximity to the cockpit.

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(b) The captain returned to the cockpit almost immediately after the dive started. There is no indication on the CVR of a struggle or disagreement between the first officer, the captain or anyone else. There was also no effort to incapacitate the first officer or to restrain him.

(c) The cockpit conversations showed an effort at teamwork rather than a crew working at cross-purposes.

(d) Only 6 degrees of elevator movement occurred during the dive, even though 15 degrees of elevator authority was available at the beginning of the dive. Further, it was calculated that at the beginning of the dive the first officer's control column moved 3.5 degrees when about 11 degrees of movement was available. Had the first officer wanted to commit suicide, he would probably have used more down elevator to cause a steeper dive.

(e) The thrust levers were reduced during the early stages of the dive. Such a control input is inconsistent with an attempt to commit suicide. To the contrary, it is compelling evidence of an effort to slow the rate of descent.

(f) The flight crew maintained an essentially wings-level attitude and a consistent heading during the dive. The flight crew also corrected for bank angle when the aircraft began to roll. This controlled flight profile is not consistent with more radical maneuvers that would probably be used if suicide were being attempted.

(g) The FDR and CVR correlation shows that soon after the dive started, the captain asked, "What is happening?" He asked this question again as the airplane was recovering. If the first officer were attempting suicide, the captain would not have asked this question as the aircraft was recovering from an 18,000 foot dive.

(h) Commands, made subsequent to the "what is happening" questions also addressed the crew's attempts to control the airplane and did not question the first officer's behavior.

(i) The crew's shutting off the fuel control levers may have been a response to a potential engine flameout. The FDR recorded a warning after a low oil pressure condition. If the crew concluded a dual engine flame-out had occurred as a result of this condition and as a result of the attitude of the airplane, they would have initiated the relight procedure which starts with moving both fuel levers to the off position.

(j) A command was given a short time later by the Captain to "shut the engines." This order was confirmed by the statement, "It's shut." This shows a crew working together.

(k) Analysis shows that the flight crew recovered the aircraft from the dive. This also indicates that the crew was working together to control the aircraft.

(5) Simulator Testing Suggests That At Least Three Crew Members Were in the Cockpit During the Dive

Simulations at Boeing suggest that the captain and the first officer were not alone in the cockpit during the dive. The presence of others is indicated by the fact that if either the captain or first officer had let go of their control columns to shut the engines or to deploy the speedbrake (as shown on the FDR), the aircraft would have pitched down at the same time. No such change in pitch was recorded on the FDR.

(6) The Split Elevators Do Not Support the Conclusion That There Was a Struggle in the Cockpit

The deliberate act theory has also been based on the FDR's recording of a split between the right and left elevators which, according to the theorists, indicated the captain's attempt to wrest control of the airplane from the first officer. After detailed analysis of the FDR and the CVR, this conclusion is seriously flawed for at least three reasons.

First, the CVR provides no indication of a struggle, argument, or refusal to follow a command. Surely, there would have been at least some noise or words recorded by the CVR had there been any hint that the first officer was acting improperly, much less trying to kill everyone on board the aircraft.

Second, the FDR does not record the position of the control column at either the captain's or the first officer's station. Accordingly, one cannot conclude from examining only the FDR data that pilot input to his control column caused the elevators to be in a given position. Instead, elevator position is recorded by

instrumentation located at the elevator hinges and could be due to pilot input, mechanical malfunction in the elevator control system, aerodynamic forces acting upon the elevator surfaces, or any combination of these. For instance, if the right elevator was being commanded by malfunctioning actuators to nose the aircraft down, the captain could, after pulling on his control column with sufficient force, cause the left elevator control to split from the right elevator and move to a position to cause the airplane to climb (as this aircraft ultimately did). The cause of the control movements in this example could not be explained by simply examining the FDR data alone, although the FDR data would be completely consistent with this possible scenario.

Third, at the same moment the elevators split, both outboard ailerons moved upward. This is a highly unusual aileron movement because (a) the ailerons, when in operation, do not both move upward simultaneously, and (b) at cruise speeds or higher, the outboard ailerons on this aircraft are locked in a faired position and cannot be activated from the crew's control columns. Further, when this unusual aileron movement occurred during the dive, the aircraft's speed was approaching Mach 1.0, and no published performance data is available to predict what will occur to the ailerons at these high speeds. It is likely, however, that aerodynamic shocks or flutter were occurring at the control surfaces, and this may have caused the unusual aileron movement. Knowing why the ailerons moved so unusually at the same time as the elevator split may provide an accurate explanation for the unusual elevator movement. Although the Egyptian investigation team has requested further

analysis of the aircraft's performance in this speed range, the NTSB has formally declined to study or investigate the reasons for the unusual aileron movement.

(7) The FBI Interview Summaries Provide No Additional Relevant Information to the Investigation

Only recently did EgyptAir learn that the NTSB decided to include FBI interview summaries as part of the "factual record." These summaries, which contain unsubstantiated and unverified statements, do not provide any information to support a motive for the first officer's alleged suicide. Indeed, had these hearsay statements been of any value as evidence of motive, the FBI would have used its authority to take over the investigation of this crash and vigorously pursued a criminal investigation. This, of course, was not done.

Any factual information contained in these summaries has already been provided in interviews conducted by the NTSB. The remaining unsubstantiated information contained in the summaries has been injected into the "factual record" apparently for the sole purpose of embarrassing and harming the first officer's wife and family.

C. Conclusion–The First Officer Did Not Commit Suicide

Accordingly, from an impartial review of the factual evidence gathered during the investigation, it is clear that the first officer did not intentionally dive the aircraft into the ocean.

4. The First Officer May Have Disengaged the Autopilot to Address an Operational Concern

It is clear from the FDR that the autopilot was disengaged several seconds before the dive began. There is, however, no direct evidence from either the CVR or the FDR to explain why the autopilot was disengaged. There is some evidence to indicate that the first officer may have been

addressing an operational concern, such as the elevator control malfunction discussed earlier, or, possibly, conflicting traffic.

Regarding the issue of conflicting traffic, analysis of available radar information indicates the possibility of at least three high-speed objects in the vicinity of the aircraft and along its flight path just before the dive. Unfortunately, the information made available to the Egyptian investigation team does not show the altitude of the targets or any other information other than speed and direction. Although the NTSB believes that these radar returns are the product of what is called "strobing," this cannot be conclusively determined based on the data available. Further information is necessary to reach this conclusion or to determine whether the targets are real.

Conclusion

At this point in the investigation considering the factual evidence gathered, it is clear that the first officer did not commit suicide. Further investigation of the elevator control system's design in conjunction with the other factual information available is necessary before a conclusion can be reached regarding the true cause of this accident. Specifically, further engineering analysis, including wind tunnel tests, is necessary to examine the dual actuator malfunction in the speed ranges for which current data is not available. In addition, further investigation of radar data is also necessary to completely rule out the possibility of conflicting traffic. Until this work is accomplished, the cause of this accident cannot be truly established.

Respectfully submitted,

EGYPTAIR

[redacted]

By:_____

Capt. Shaker Kelada
Vice President of Safety and
EgyptAir's Representative
to the Flight 990 Investigation