

UNITED STATES OF AMERICA
NATIONAL TRANSPORTATION SAFETY BOARD

PUBLIC HEARING
AMERICAN AIRLINES FLIGHT 587
BELLE HARBOR, NEW YORK

Tuesday, October 29, 2002

APPEARANCES:

Members of the Board:

CAROL CARMODY, Acting Chairman
JOHN J. GOGLIA
JOHN HAMMERSCHMIDT
GEORGE W. BLACK

National Transportation Safety Board
Technical Panel:

STEVE MAGLADRY
JOHN CLARK
JOHN O'CALLAGHAN
CAPT. DAVE IVEY
DR. MALCOLM BRENNER
ROBERT BENZON
LORENDA WARD, Hearing Officer

On behalf of American Airlines, Inc.:

CAPT. ROBERT AHEARN

On behalf of the Allied Pilots Association:

CAPT. DONALD W. PITTS

On behalf of Airbus:

DR. JOHN LAUBER

On behalf of the Federal Aviation
Administration:

HAROLD DONNER

APPEARANCES: (Continued)

On behalf of the Bureau D'Enquetes et
D'Analyses pour la Securite de L'Aviation
Civile (BEA):

PIERRE JOUNIAUX

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P R O C E E D I N G S

9:39 a.m.

CHAIRMAN CARMODY: Good morning. Some of you may wonder why there are so many empty seats. We're holding those vacant for a while because we're expecting some family members arriving later this morning, and we wanted to be sure they had a seat. So they may be released later, but right now we're trying to hold them free.

Good morning, ladies and gentlemen, and welcome to the NTSB. My name is Carol Carmody. I'm the acting chairman of the National -- Transportation Safety Board and the chairman of this board of inquiry.

Today we're opening a public hearing concerning the accident that occurred on November the 12th, 2001, at Belle Harbor, New York, involving American Airlines Flight 587. There were 265 fatalities from that crash, the second deadliest in U.S. history.

I'd like to acknowledge today in the -- in the audience are family members of those who lost their lives. I want to express my profound condolences for your loss, and I am joined in that by the entire Safety Board and by all the parties to this hearing.

We can't change the tragedy that occurred on

1 November the 12th, but what we can do is assure the
2 families of the passengers and the crew that the Safety
3 Board will pursue every lead in search of answers for
4 the cause.

5 Our nation was still stunned by the events of
6 September the 11th when this crash occurred on November
7 the 12th, 2001. Although there were no indications of
8 terrorist activity associated with it, that possibility
9 could not be discounted. Therefore, in addition to the
10 NTSB Go Team which was dispatched immediately, the FBI
11 also sent a team to the site. And that agency has been
12 in regular touch with the Board ever since.

13 There is no indication to date of any
14 criminal activity associated with the crash.

15 Information from this hearing will supplement
16 the facts, conditions, and circumstances discovered the
17 on-scene and continuing investigation. This process
18 will assist the Board in determining the probable cause
19 of the accident and in making any recommendations to
20 prevent similar accidents in the future. We will not
21 render a determination of cause during these
22 proceedings.

23 This investigation has taken investigators
24 not just to New York but to France, Germany, Oklahoma,
25 Virginia, Arizona, Washington state, and California.

1 The volumes of pages of information we've released this
2 morning are the work of scores of investigators
3 representing government and private industry.

4 The purpose of this hearing is twofold.
5 First, the issues that will be discussed at this
6 hearing will assist the Safety Board in developing
7 additional factual information to analyze to determine
8 the cause of the accident. Second, this hearing gives
9 the aviation community and the traveling public a
10 chance to see a portion of the investigative process
11 and a view of the dedicated efforts of the many
12 investigators from different organizations in their
13 effort to find answers.

14 I might also add, the hearing is available as
15 a live Web cast through the Safety Board's Web site,
16 which is www.nts.gov.

17 Public hearings such as this one are
18 exercises in accountability: accountability on the
19 part of the Safety Board that it is conducting a
20 thorough and fair investigation; accountability on the
21 part of the FAA that it is adequately regulating the
22 industry; accountability on the part of the airline
23 that it is operating safely; accountability on the part
24 of the manufacturers for the design and performance of
25 their products; and accountability on the part of the

1 work force, including pilots and mechanics, that they
2 are performing up to the high standards expected of
3 them.

4 These proceedings tend to become highly
5 technical affairs, but they are essential, we think, in
6 seeking to reassure the public that everything is being
7 done to ensure the safety of the airline industry.

8 This board of inquiry is not intended to
9 determine the rights or liability of private matters,
10 and matters dealing with such rights or liability will
11 be excluded from these proceedings. Our purpose is to
12 collect information that will assist the Board in
13 examination of safety issues arriving from this --
14 arising from this accident.

15 Specifically, we'll concentrate on the
16 following issues.

17 Number one, the design and certification of
18 the vertical stabilizer and the rudder.

19 Number two, the rudder system design,
20 certification, and operation.

21 Number three, wake turbulence.

22 And number four, -- operations and training.

23 At this point, I'd like to introduce my
24 colleagues and the other members of the Board.

25 To my left, Member John Hammerschmidt. To my

1 right, Member John Goglia. And on the end, Member
2 George Black. George Black was on scene at the
3 accident of 587.

4 The Board will be assisted by a Technical
5 Panel consisting of the following Safety Board staff:
6 Mr. Robert Benzon, investigator in charge; Ms. Lorenda
7 Ward, hearing officer; Mr. John Clark, director of
8 aviation safety; Mr. Tom Haueter, deputy director of
9 aviation safety; Dr. Vern Ellingstad, director of
10 research and engineer; Dr. Alan Kushner, deputy
11 director of research and engineering; Mr. Steve
12 Magladry, systems group chairman; Capt. David Ivey,
13 operations group chairman; Dr. Malcolm Brenner, human
14 performance group chairman; Mr. John O'Callaghan,
15 aircraft performance group chairman; and Dr. Matt Fox,
16 materials group chairman.

17 Since this accident involved a foreign-
18 manufactured aircraft, in accordance with Annex 13 of
19 the Chicago Convention, the Technical Panel will also
20 include members from the BEA, which is the French
21 equivalent of the NTSB. Mr. Pierre Jouniaux, Mr.
22 Bernard Bourdon, and Mr. Thierry Loo.

23 Mr. Ted Lopatkiewicz and his colleagues from
24 the Safety Board's Public Affairs Office are here to
25 assist members of the news media.

1 Ms. Brenda Yager and Sharon Bryson from the
2 Office of Transportation Disaster Assistance are here
3 to assist any family members in the audience.

4 Ms. Carolyn Dargan and Christine Carey are
5 here to -- are present to provide administrative
6 support as needed. They will also be providing copies
7 of exhibits to witnesses.

8 Neither I nor any other Safety Board
9 personnel will attempt during this hearing to analyze
10 the testimony received, nor will any attempt be made at
11 this time to determine the probable cause of the
12 accident. Such analyses and determinations of cause
13 will be made by the full Safety Board after
14 consideration of all the evidence gathered during our
15 investigation.

16 The final report on the accident reflecting
17 the Safety Board's analyses and probable cause
18 determinations will be considered for adoption by the
19 full Board at a public meeting here at the Safety
20 Board's headquarters at a future date.

21 Safety Board's rules provide for the
22 designation of parties to a public hearing. In
23 accordance with these rules, those persons,
24 governmental agencies, companies, and associations
25 whose participation in the hearing is deemed necessary

1 in the public interest and whose special knowledge will
2 contribute to the development of pertinent evidence are
3 designated as "parties." The parties assisting the
4 Safety Board in this hearing have been designated in
5 accordance with these rules.

6 As I call the name of each party to the
7 hearing, would that designated spokesperson please give
8 his or her name, title, and affiliation for the record?

9 First, the Federal Aviation Administration.

10 MR. DONNER: Good morning, Madam Chairman.
11 My name is Bud Donner. I'm the manager of the Accident
12 Investigation Division, Federal Aviation
13 Administration.

14 CHAIRMAN CARMODY: Thank you.

15 American Airlines?

16 CAPT. AHEARN: Good morning, Madam Chairman.

17 My name is Tim Ahearn. I'm vice president of safety,
18 security, and environmental for American Airlines. I'm
19 the chairman -- here on behalf of American Airlines.
20 I'd also want to acknowledge the tremendous losses
21 suffered by the families of the victims on Flight 587
22 and as well offer our condolences and sorrow for the
23 losses. Thank you, Madam.

24 CHAIRMAN CARMODY: Thank you, Mr. Ahearn.

25 Airbus?

1 DR. LAUBER: Yes, Madam Chairman. I am John
2 Lauber. I'm vice president of safety and technical
3 affairs for Airbus North America. And I too would like
4 to thank you for your statement of condolence on -- on
5 behalf of all of the parties. It certainly captures
6 the sentiments of all of us at Airbus. And we look
7 forward to contributing to the investigation to make
8 sure that this never happens again. So thank you.
9 Excuse me. Thank you.

10 CHAIRMAN CARMODY: Thank you, Dr. Lauber.
11 Allied Pilots Association.

12 CAPT. PITTS: Good morning, Madam Chairman.
13 I am Capt. Don Pitts, chairman, Safety Committee. On
14 behalf of the 14,000 pilots represented by the Allied
15 Pilots Association, I would like to add to your
16 comments our heartfelt sorrow for those who have
17 suffered as a result of this accident.

18 CHAIRMAN CARMODY: Thank you, Capt.
19 Pitts.

20 I would like to also thank publicly all of
21 the private, municipal, county, state, and federal
22 agencies that have supported the Safety Board
23 throughout this investigation. They're really too
24 numerous to mention, but we owe them a great deal.

25 On October the 21st of this year, this Board

1 of Inquiry held a pre-hearing conference here in this
2 facility. It was attended by the Safety Board's
3 Technical Panel and representatives of the parties to
4 the hearing.

5 During that conference, the areas of inquiry
6 and the scope of the issues to be explored were
7 delineated and the selection of witnesses was
8 finalized. Copies of the witness list developed at the
9 pre-hearing conference are available in the foyer.

10 There are numerous exhibits that will be used
11 in this proceeding. Copies of the exhibits may be
12 ordered through our Public Inquiries Branch at 202-314-
13 6551 and may also be found on the Board's Web site,
14 which I noted previously.

15 The witnesses testifying at this hearing have
16 been selected because of their ability to provide the
17 best available information on the issues.

18 The investigator in charge of the accident
19 will summarize certain facts about it and -- and the
20 investigative activities that have taken place to date.

21 Following this, the first witness will be called.

22 The witnesses will be questioned first by the
23 Board's Technical Panel, then by the designated
24 spokesperson for each party to the hearing, and finally
25 by the Board members.

1 As chairman of the Board of Inquiry, I will
2 be responsible for the conduct of the hearing. I will
3 make all rulings on the admissibility of evidence and
4 all rulings will be final.

5 The record of the investigation, including
6 the transcript of the hearing and all exhibits entered
7 into the record, will become part of the Safety Board's
8 public docket and will be available for inspection at
9 the Board's Washington office. Anyone wanting to
10 purchase the transcript, including the parties to the
11 investigation, should contact the court reporter
12 directly.

13 Let me just note here, in case of an
14 emergency of some sort such as a fire, the building
15 alarm system will activate and a voice message will
16 instruct persons to vacate the building. You should
17 proceed then to the nearest exit. There are emergency
18 exits up front on either side of the stage and of
19 course at the back of the room.

20 Also, for convenience, restrooms and
21 telephones are in the foyer on your left as you enter
22 -- as you exit the room.

23 And also, I would ask to provide the
24 appropriate setting for the hearing that if you have
25 cell phones, pagers, or beepers, that you put them on

1 "silence" as so not to disrupt the proceeding.

2 Mr. Benzon, are you ready to proceed with the
3 summary?

4 MR. BENZON: Yes, ma'am.

5 CHAIRMAN CARMODY: Please do so.

6 SUMMARY STATEMENT

7 MR. BENZON: Good morning. On November 12th,
8 2001, at approximately 9:16 a.m., American Airlines
9 Flight 587, an Airbus A-300, crashed into a
10 neighborhood in Belle Harbor, New York. And this
11 occurred shortly after takeoff from Kennedy
12 International Airport. The plane was on a scheduled
13 flight from Santo Domingo, Dominican Republic.

14 (Slide)

15 MR. BENZON: As depicted in this slide, the
16 vertical stabilizer and rudder were found in Jamaica
17 Bay, about one mile from where the main wreckage
18 eventually impacted. The engine struck the ground
19 several blocks north of the main wreckage, and then the
20 remainder of the aircraft impacted at the intersection
21 of Newport and 131st Street. All 260 persons on board
22 died as -- as did five residents of Belle Harbor.

23 I will be stepping through a timeline of
24 events from takeoff until aircraft impact very shortly.

25 (Slide)

1 MR. BENZON: Safety Board investigators from
2 our Northeast Regional Office arrived shortly after the
3 accident to coordinate NTSB activity with local
4 authorities and to secure perishable evidence. Later
5 that day, a full team of 40 NTSB investigators and
6 support staff arrived at the accident site and began
7 work in a dozen different specialties.

8 (Slide)

9 MR. BENZON: Board member George Black,
10 former chairman Marion Blakey, public relations
11 personnel, and NTSB Transportation Disaster Assistance
12 representatives accompanied the investigators. Other
13 investigators simultaneously began background work on
14 the accident back here in Washington, D.C.

15 Because the aircraft involved in the accident
16 was designed and built by Airbus and certified by the
17 French government, the Bureau Enquetes Accidents
18 provided a French accredited representative and
19 investigators to assist in the investigation.

20 (Slide)

21 MR. BENZON: The Safety Board spent about one
22 week at the accident site to document -- documenting
23 the wreckage in place. This slide depicts the accident
24 site about two days after the accident.

25 During this week, the engines were removed

1 for future teardown examinations in Tulsa, Oklahoma,
2 and the majority of the vertical stabilizer and rudder
3 assemblies were recovered from the water underneath the
4 final flight path of 587. These components were
5 removed to an unused hangar at Floyd Bennett Field
6 close to the impact site for initial visual
7 examination.

8 (Slide)

9 MR. BENZON: In addition, an NTSB aircraft
10 performance engineer was dispatched to Toulouse,
11 France, to begin working with Airbus engineers on
12 aerodynamic loads calculations.

13 (Slide)

14 MR. BENZON: To date, the investigation
15 activity has also been accomplished in Stade, Germany,
16 where the vertical stabilizer was built. The NTS --
17 I'm sorry. The NASA Langley Hampton, Virginia facility
18 for composite material examination. The NASA Ames
19 Mountain View, California facility, home of the most
20 sophisticated motion simulator in the world. Sandia
21 National Laboratory in New Mexico. The Ford Motor
22 Company CAT Scan facility in Detroit, Michigan. And
23 the U.S. Army Proving Ground CAT Scan facility in
24 Maryland.

25 Now I'd like to go into the accident sequence

1 itself a bit.

2 (Slide)

3 MR. BENZON: Based on radar and FDR data,
4 Flight 587 took off approximately 101 seconds behind
5 Japan Airlines Flight 47, which was a Boeing 747. The
6 FDR indicates that the flight -- that Flight 587
7 encountered to wake vortices generated by JAL Flight
8 47. The second wake encounter occurred about 10
9 seconds before the ending of the FDR data. And
10 following the second wake encounter, the aircraft
11 responded to flight control inputs. Both wake
12 encounters averaged about 0.1 G lateral movement, that
13 is side to side.

14 (Slide)

15 MR. BENZON: And during the last eight
16 seconds of FDR data, the plane experienced three
17 stronger lateral movements, two to the right, and one
18 to the left. These lateral force excursions were
19 consistent with rudder movements.

20 The left-pointing horizontal arrows on this
21 slide show where the accident aircraft encountered the
22 two wake vortices. The right-pointing arrows show the
23 direction of travel of the vortices as they were
24 carried by the wind. And the vertical arrows show
25 where the JAL 747 was by the time of the two vortex

1 encounters.

2 (Slide)

3 MR. BENZON: Now, we can see the wake
4 encounters on the vertical acceleration traces of the
5 FDR. Here is the first wake encounter.

6 (Slide)

7 MR. BENZON: And here is the second wake
8 encounter.

9 (Slide)

10 MR. BENZON: And here, on the rudder position
11 trace, is where we believe the vertical stabilizer
12 broke away from the airplane. Currently, it appears
13 that the rudder was still attached at the time the
14 vertical stabilizer separated from the fuselage.

15 (Slide)

16 MR. BENZON: We now have three visual
17 presentations to show you. The presentations that
18 follow depict the accident events somewhat graphically
19 but not exceedingly so. If any family members wish not
20 to see this material, we'll pause for a moment now so
21 you can relocate.

22 (Pause)

23 MR. BENZON: Okay. The first presentation
24 was taken by a construction crew working at JFK with a
25 video camera and it filmed both the departure of the

1 Boeing 747, that's JAL Flight 47, and American Airlines
2 Flight 587. And the video is playing now.

3 (Video presentation)

4 MR. BENZON: Security cameras from the
5 Metropolitan Triborough Bridge and Tunnel Authority at
6 the Marine Parkway Bridge also recorded most of the
7 accident sequence itself. This tape includes two
8 simultaneous video clips of the accident airplane in
9 the far distance. The image is very, very small. The
10 clips have been time correlated by using surveying
11 techniques and radar data.

12 The left clip shows the airplane flying
13 through the frame from left to right, and the right
14 clip shows the airplane on a somewhat parabolic descent
15 from left to right. And shortly thereafter, you'll see
16 an image of some smoke observed rising from the ground.

17 Now, we will show this video twice, once with
18 a white circle around the very small image of the
19 airplane and again without the white circle. Based
20 upon our correlation, we believe that the vertical
21 stabilizer separated while the airplane was in view in
22 the left clip. However, careful examination of the
23 video in our laboratory revealed no images of any
24 object falling off the airplane.

25 In the right clip, you will note a lighter

1 colored smear or smudge develop as the clip plays a
2 bit. The staff believes that this could be misting
3 fuel, it could be smoke, or even flame that spread from
4 the airplane after the engines broke away from the
5 wing. Again, we could find no images of anything
6 falling off the airplane.

7 (Video presentation)

8 MR. BENZON: I notice the -- the smear there.

9 (Video presentation)

10 MR. BENZON: Last, a video animation of the
11 accident takeoff and the loss of control about a minute
12 and a half later was completed by the Safety Board, and
13 we will show it to you in a minute. The animation is
14 based upon derived information from the flight data
15 recorder.

16 I need to brief you a bit on what you're
17 going to see because it's kind of a complicated little
18 clip. You'll first note that we are superimposing
19 selected wording from the CVR transcript and other
20 sources over the image of the airplane. These words
21 only appear for a few seconds and will not impede the
22 view of the airplane.

23 A little lower on the instrumental panel
24 portion of the animation you will see the elapsed time,
25 altitude, and an airspeed read-out.

1 The big round object, the blue and brown
2 object, is an attitude indicator that will show you the
3 pitch angle of the airplane and its roll angle or its
4 bank angle.

5 To its right is the airplane's control wheel.

6 Next to it is a vertical accelerometer that will tell
7 you how heavy the pilots feel in the seat, how many G's
8 they're experiencing.

9 A sliding triangle on the rudder pedal
10 indicator tells you how much the rudder pedals are
11 deflected. And the rudder surface indicator, along
12 with the tail section depiction, tells you how much the
13 rudder itself is deflected.

14 The red lines on the tail section depiction
15 show the rudder limiter, and you will see these red
16 lines come closer together. They're in a chevron shape
17 and they'll kind of squeeze together as the air speed
18 increases.

19 And last, you will note the lateral
20 acceleration indicator that indicates the amount of
21 side-to-side forces that are existing at any given
22 moment during the flight.

23 We'll run the first run of the full animation
24 in real time from taxi to the end. Now, keep in mind
25 that the entire flight was only about a minute and a

1 half long, and some events occur very rapidly,
2 especially near the end of the animation.

3 Also, the flight data recorder quit working
4 before the crash. The animation will stop at that
5 point, but the CVR text, which continued to record,
6 will continue to scroll. And next, we'll then run the
7 full final segment at one-half speed so you can better
8 see the relative motion of the airplane and its
9 controls. And finally, we'll run the final segment
10 again in real time.

11 And we can play that now.

12 (Video presentation)

13 MR. BENZON: And that's the JAL flight on the
14 top of the screen.

15 (Video presentation)

16 MR. BENZON: When the air speed begins to
17 increase, that's the time that he begins the takeoff
18 roll.

19 (Video presentation)

20 MR. BENZON: And again, the things to watch
21 out for are yoke movement or control wheel movements
22 that are quite dramatic and the rudder position.

23 (Video presentation)

24 MR. BENZON: Okay. The takeoff roll is
25 beginning.

1 (Video presentation)

2 MR. BENZON: The yoke comes back for the
3 rotation. And he broke ground.

4 (Video presentation)

5 MR. BENZON: The gear and flaps are coming up
6 now.

7 (Video presentation)

8 MR. BENZON: And he is rolling wings
9 level.

10 (Video presentation)

11 MR. BENZON: We think that's the first wake
12 encounter.

13 (Video presentation)

14 MR. BENZON: And the second wake encounter.

15 (Video presentation)

16 MR. BENZON: Now we'll be running the end
17 portion of the tape in slow motion, one-half speed.

18 (Video presentation)

19 MR. BENZON: First wake.

20 (Video presentation)

21 MR. BENZON: Second wake, and notice the
22 rudder on the right side.

23 (Video presentation)

24 MR. BENZON: Now, this time will be real
25 time. And if you want to notice on the right side of

1 the screen when the image of the rudder disappears,
2 that's when we believe it departed the airplane.
3 Again, this is real-time.

4 (Video presentation)

5 MR. BENZON: First wake.

6 (Video presentation)

7 MR. BENZON: Second wake.

8 (Video presentation)

9 MR. BENZON: And the tail's gone.

10 (Video presentation)

11 MR. BENZON: Okay. I would like now to
12 summarize the accident sequence of events using a map
13 of the New York area, if I may. Next slide, Chris.

14 (Slide)

15 MR. BENZON: Okay. The yellow arrow on the
16 -- in the upper right-hand corner of the slide shows
17 the liftoff point from the runway. And the flight path
18 down to the south over the Rockaways. Next slide.

19 (Slide)

20 MR. BENZON: This is the first wake encounter
21 at 9:15 and 36 seconds. And next slide.

22 (Slide)

23 MR. BENZON: This is the -- when the captain
24 comments about the wake, and that occurs at 44 seconds
25 after the minute. And next slide.

1 (Slide)

2 MR. BENZON: At 9:15 and 51, he encounters
3 the second wake. Next slide.

4 (Slide)

5 MR. BENZON: And at 9:15 and 58 and a half
6 seconds, we believe the vertical stabilizer left the
7 airplane. Next slide.

8 (Slide)

9 MR. BENZON: The fuel spray or fire or
10 whatever you'd like to call it occurred at 9:16 and six
11 seconds at this location. And note that's right over
12 the coastline for the -- the peninsula there and right
13 where a lot of our eyewitnesses were. Next slide.

14 (Slide)

15 MR. BENZON: And this last slide shows the
16 wreckage locations, the vertical stabilizer and rudder
17 in the water. The left engine and right engine are a
18 little farther into the peninsula. And the main impact
19 site is about halfway between the two beaches.

20 (Slide)

21 MR. BENZON: I'd like to now -- to describe
22 some of the investigative activity that has been
23 accomplished and will not be subjects of this hearing
24 -- not be a subject of the hearing. These subjects
25 for the most part are no longer active areas of

1 investigation because the staff believes that they are
2 not associated with the reason this tragedy occurred.

3 I must reemphasize, however, that this public
4 hearing is not the end of the investigation. Any area
5 of inquiry can be reopened with sufficient reason, and
6 we simply are not finished with some of our inquiries
7 in different areas.

8 Concerning sabotage. Numerous criminal
9 investigation agencies led by the FBI were immediately
10 involved with the Safety Board in careful examination
11 of all recovered wreckage on scene. There was no
12 evidence of high-speed object impacts, supersonic gas
13 washing, micro particle pitting, or explosive residue
14 on any aircraft component.

15 The Board also discovered no unusual
16 indications on the flight data recorder or the cockpit
17 voice recorded that would indicate foul play. And
18 last, the sequence of events itself as previously
19 described is not consistent with sabotage.

20 Interviews with those associated with the
21 ground operation of the flight were conducted.
22 Passenger background checks were accomplished by the
23 FBI and the police. And the efficiency of airport
24 security measures was also examined by law enforcement
25 authorities.

1 In short, no evidence of sabotage was -- was
2 discovered by the Board or any law enforcement agency.

3 Concerning weather at the time of the
4 accident, at 9:25 a.m., about five minutes after the
5 crash, a special weather observation was taken. And it
6 revealed that the winds were out of 270 degrees at
7 eight knots. The visibility was 10 miles. A few
8 clouds were present at 4800 feet and the temperature
9 was 42 degrees Fahrenheit. There was no indication of
10 any adverse weather at all.

11 Concerning air traffic control activities,
12 all air traffic control directions and clearances given
13 to Flight 587 and spacing between 587 and the Boeing
14 747 were in accordance with current FAA regulations and
15 guidelines. However, the wake vortex encounter itself
16 experienced by Flight 587 is a topic of this hearing.

17 Concerning the aircraft's engines, teardowns
18 of both engines and the auxiliary power unit revealed
19 no indications on either engine or the APU of
20 uncontained failure, case rupture, in-flight fire, or
21 pre-impact malfunction. In addition, the flight data
22 recorder engine parameters revealed no anomalies.

23 The staff therefore believes that the engines
24 did not contribute to the cause of this accident.

25 Concerning bogus or unauthorized aircraft

1 parts, in late February of this year investigators
2 became aware of a group of apparently bogus aircraft
3 components that were allegedly being shipped to the
4 United States from Italy. However, no bogus parts were
5 discovered to be associated with Flight 587.

6 Concerning eyewitnesses, the Board has
7 received about 350 accounts from eyewitnesses either
8 through direct interviews that we or the police
9 conducted or through written statements obtained by the
10 Board. A summary of those statements has been
11 previously been made public, and the full witness
12 reports are available in the public docket, which is
13 now open.

14 A number of witnesses reported seeing fire
15 either on the fuselage, at the engines, or at or near
16 the wings. Some reported an explosion. Some saw no
17 fire. Some saw the airplane wobbling, dipping, or
18 moving side to side, and some saw something separate
19 from the airplane.

20 Investigators believe that the observations
21 of fire and smoke are normal in an in-flight event such
22 as this. Flames, smoke, and misting fuel often occur
23 as aircraft engines rip off the wing during similar
24 situations.

25 In similar events in the past, the disruption

1 of air flow into the engines also often causes loud
2 bangs and large flames to emit from either the back or
3 the front of the engines themselves, and these are
4 collectively known as compressor surges. It's a known
5 phenomenon.

6 In short, many of the statements we have
7 received are quite consistent with the sequence of
8 events that occurred.

9 Concerning aircraft systems, to date
10 investigators have found no indications of rudder
11 system anomalies. And the investigation in this area
12 does continue.

13 Concerning aircraft structures, structures
14 investigators continue to look for preexisting damage
15 to the vertical stabilizer. But again, to date
16 investigators have found no indications of any
17 structural anomalies on the airplane.

18 It must be noted that even if damage did
19 exist to the airplane's vertical stabilizer, the
20 stabilizer structure remained intact until the loads it
21 sustained were very, very high. The external
22 aerodynamic loads of the internal loads for the
23 vertical stabilizer are a topic of this hearing.

24 But it should be noted that the extensive
25 calculations accomplished by Airbus and independently

1 by the Safety Board reveal that the physical loads that
2 the vertical stabilizer experienced were significantly
3 above the ultimate maximum limits required by the
4 French and American certification standards. In fact,
5 the sustained loads were near the structural test limit
6 demonstrated during the certification process.

7 Concerning Flight 587 maintenance records,
8 all periodic maintenance examinations of the aircraft
9 were on time and in accordance with current FAA
10 guidelines. The last visual inspection of the airplane
11 or of the vertical stabilizer and rudder specifically
12 was conducted on December 9th, 1999, during a heavy
13 maintenance check. Nothing unusual was noted during
14 that visual inspection.

15 On the morning of the accident, a pitch trim
16 and a yaw damper would not engage during a pre-flight
17 check. The computer controlling these components was
18 reset by a mechanic and this appeared to solve the
19 problem. There were no open maintenance items
20 regarding the vertical stabilizer and rudder system
21 when the aircraft took off.

22 Concerning flight data recorder problems, the
23 analysis of the flight data recorder, a vital tool in
24 aircraft accident investigation, was much more
25 difficult than it needed to be because signals from

1 some FDR parameters were filtered before they reached
2 the flight recorder. As a result, the readings on the
3 recorder show what gauges were telling the pilots but
4 not necessarily what was actually occurring on a real-
5 time basis to the aircraft.

6 In 1994, the Safety Board recommended to the
7 FAA that such filtering be removed from information
8 sent to the flight recorders. And yet in 2001, this
9 investigation was hampered by totally unacceptable
10 filtering of the data. In addition, the sampling rates
11 of such data are simply not adequate.

12 The staff and the Board are addressing these
13 issues separate from this hearing.

14 Concerning NTSB recommendations, the Board
15 has issued two recommendations to the FAA so far during
16 this investigation, and I -- I believe they're very
17 important ones. These two are considered so important
18 that we could not wait to the conclusion of the
19 investigation to put them out.

20 The two safety recommendations address the
21 fact that many pilot training programs do not include
22 the information about the structural limits for the
23 rudder and the vertical stabilizer on the airplanes the
24 pilots fly. Significantly full rudder inputs, even at
25 speeds below maneuvering speed, may result in

1 structural loads that exceed certification
2 requirements.

3 However, pilots may have the impression that
4 the rudder limiter systems on their airplanes prevent
5 cyclic full rudder deflections from damaging the
6 structure, and this is simply not true.

7 The structural certification requirements for
8 transport category airplanes do not take such maneuvers
9 into account. Therefore, such cyclic rudder inputs,
10 even when a rudder limiter is in effect, can produce
11 loads that may exceed the structural capabilities of
12 the aircraft.

13 The staff is continuing to evaluate whether
14 the pilots caused the rudder to move in this case or if
15 a rudder system anomaly could have contributed to the
16 movement. Regardless, the staff believes that the
17 rudder movement resulted in most, if not all, of the
18 loads imposed on the vertical stabilizer during this
19 event.

20 Now, concerning the recommendations
21 themselves, specifically, the Board asks the FAA to
22 require the manufacturers and operators to ensure that
23 pilot training programs do three things. Pilots need
24 to be explained that the structural certification
25 requirements for the rudder and the vertical stabilizer

1 exist. And an explanation is needed concerning what a
2 full or nearly full rudder deflection in one direction
3 can -- can do to an airplane. And lastly, it needs to
4 be explained to the crew force that on some aircraft,
5 as speed increases, a maximum available rudder
6 deflection can be attained with relatively light pedal
7 forces and small pedal deflections.

8 Madam Chairman, this concludes my opening
9 statement.

10 CHAIRMAN CARMODY: Thank you, Mr. Benzon.

11 Ms. Ward, are you prepared to call the first
12 witness?

13 MS. WARD: Yes, I am, Madam Chairman. I'd
14 like to call Mr. Dominique Chatrenet and also Mr.
15 Dominique Van den Bossche.
16 Whereupon,

17 DOMINIQUE CHATRENET
18 having been first duly sworn, was called as a witness
19 herein and was examined and testified as follows:
20 Whereupon,

21 DOMINIQUE VAN den BOSSCHE
22 having been first duly sworn, was called as a witness
23 herein and was examined and testified as follows:

24 MS. WARD: Please have a seat, then. Thank
25 you.

1 (Pause)

2 MR. MAGLADRY: Thank you, Ms. Ward and Madam
3 Chairman.

4 MS. WARD: Mr. Magladry, I need to qualify
5 the witnesses first.

6 Mr. Chatrenet, would you please state your
7 full name, your current employer, and your business
8 address?

9 MR. CHATRENET: Yes. My name is Dominique
10 Chatrenet. I'm working for Airbus. And my business
11 address is Airbus France, Route de Bayonne, Toulouse,
12 in France.

13 MS. WARD: And what is your current position
14 and how long have you held that position?

15 MR. CHATRENET: I am working for Airbus
16 Engineering. I am vice president, head of the Flight
17 Control and Hydraulic Department -- and I'm leading the
18 situation since year 2001.

19 MS. WARD: And could you briefly describe
20 your duties and responsibilities, also including the
21 education and training that you may have received that
22 qualifies you for that position?

23 MR. CHATRENET: Yes. So the domain is in
24 charge of the flight control system, which includes
25 primary flight control system and the ILS system as

1 well, the autopilot system, the hydraulic system, and
2 the -- and flight control, those activities which are
3 associated with these systems.

4 The domains has a little more of 300
5 engineers working in Germany, Great Britain, and
6 France.

7 MS. WARD: Thank you.

8 Mr. Van den Bossche, could you please state
9 your full name, your current employer, and also your
10 business address?

11 MR. VAN den BOSSCHE: Dominique Van den
12 Bossche, Airbus, 316 Route de Bayonne, Toulouse,
13 France.

14 MS. WARD: And how -- and what is your
15 current position, and how long have you held that
16 position?

17 MR. VAN den BOSSCHE: My current position is
18 head of department in the Engineering organization in
19 Dominique Chatrenet's domain. I'm in this position
20 since 2001.

21 MS. WARD: And could you also briefly
22 describe your duties and responsibilities and any
23 education or training that you may have received that
24 qualifies you for that position?

25 MR. VAN den BOSSCHE: As head of the primary

1 flight control actuation and hydraulic departments, I
2 manage a department which primary activity is
3 development of flight control and hydraulic equipment
4 for all the aircraft of the Airbus family, A-300 to the
5 S programs. And I -- the department counts about 100
6 engineers shared over France and Germany.

7 In addition to the management of this
8 department, I'm personally involved in technical
9 committees, international or national, like SIE
10 committees -- or ISO.

11 I received a Masters degree in hydraulic
12 engineering in 1971. I joined Airbus at that time as a
13 development engineer for the S-300 primary flight
14 control actuation system. I then was involved in the
15 A-310 and A-300-600 developments, A-320, A-340, as well
16 as assigned as a -- as the primary flight control
17 actuation and head of group -- head of group in '88.
18 And I was assigned to my current position in 2001.

19 MS. WARD: Thank you, Mr. Van den Bossche.

20 Madam Chairman, I find these witnesses
21 qualified and now turn it over to Mr. Steve Magladry
22 for questioning.

23 CHAIRMAN CARMODY: Thank you.

24 Mr. Magladry?

25 MR. MAGLADRY: Thank you, Ms. Ward and Madam

1 Chairman.

2 TESTIMONY OF MR. CHATRENET AND MR. VAN den BOSSCHE

3 MR. MAGLADRY: Good morning, Mr. Chatrenet.

4 MR. CHATRENET: Yes, good morning.

5 MR. MAGLADRY: Good morning, Mr. Van den
6 Bossche.

7 I'd like to begin the questioning this
8 morning with a discussion of the rudder control system
9 for the accident airplane, the A-300-600.

10 Mr. Chatrenet, can you please provide an
11 overview of how the rudder is controlled? I understand
12 you have a brief presentation for those purposes?

13 MR. CHATRENET: Yes. Yes, I --

14 MR. MAGLADRY: For -- for those that cannot
15 see the illustrations, this information has been
16 provided in the Docket Exhibit 9-A, page four.

17 MR. CHATRENET: Yes. So this is an
18 illustration of the rudder control system of the A-300
19 dash 600.

20 (Slide)

21 MR. CHATRENET: So starting from the pedal in
22 the front part of the fuselage, the motion of the pedal
23 is transmitted to the rear of the fuselage, first
24 through rods and then to cables starting from the front
25 quadrant and with a pair of cables running along the

1 fuselage down to the rear quadrant of the fuselage.

2 At this stage, the motion of the pedal will
3 react against the strings of the artificial feed unit
4 which provide at the same time the trim function.

5 In this rear assembly, the motion coming from
6 the autopilot servo actuator, which are here, will be
7 transmitted to the whole linkage and will carry on the
8 orders from the autopilot to the rudder.

9 At this level, a differential unit will
10 authorize to add the orders coming from the "u" number
11 servo actuator, which is here, and which provides for
12 the yaw damping and turn coordination function.

13 The results of this addition will then go
14 through the rudder travel limiter, which is illustrated
15 there. And finally, this motion will be the input of
16 the three servo actuators which will drive the rudder.

17 (Slide)

18 MR. CHATRENET: This is basically a same
19 picture that's showing the functionality. We can
20 recognize here the rudder pedals, the cables, the
21 spring, and the trim function. The addition of the
22 autopilot order at this stage. The addition of the yaw
23 damper orders. The limitation provided by the rudder
24 travel limit. And then the three actuators.

25 The rudder travel limit controlled by the

1 FLC's computer while the autopilot actuator are
2 controlled by the autopilot computer and the yaw damper
3 by the AVC computer.

4 MR. MAGLADRY: Just for clarification, some
5 control surfaces have the ability to, as they say,
6 "break out." The pilot's controls would move -- can
7 move independently of the other pilot's controls. Is
8 that the case with the rudder pedals for the A-300-600?

9 MR. CHATRENET: Could you clarify your
10 question, please?

11 MR. MAGLADRY: Can the rudder pedals move
12 independently? The pilot's and the first officer's?

13 MR. CHATRENET: No. No. They are rigidly
14 connected together.

15 MR. MAGLADRY: Thank you. Now I'd like to
16 focus attention first to the yaw damper operation. And
17 could you please describe its function?

18 MR. CHATRENET: The -- the yaw damper
19 function, the main function is to provide the yaw
20 damping of the aircraft through the use a yaw rate
21 measurement which will compute the rudder order by the
22 flight augmentation computer and which will drive the
23 input of the rudder actuators.

24 The yaw damper has also the function of
25 providing an automatic turn coordination to help the

1 aircraft to fly in coordinated turn without the need
2 for pilot doing that.

3 The yaw damper order is additive -- is added
4 to the orders coming from the pilot input from the
5 rudder pedals.

6 What is important also to notice is that the
7 activity of the yaw damper will not move the pedal in
8 normal operation. And overall, the yaw damper
9 authority is limited and is roughly equal to one-third
10 of the authority of the pilot coming from the pedals.

11 This function is computed in the AVC
12 computers, and this function is a monitored one.

13 MR. MAGLADRY: Do you have an illustration of
14 the yaw damper system?

15 MR. CHATRENET: Yes, we could -- we could
16 show another slide. And maybe Dominique Van den
17 Bossche will explain more about the monitoring
18 function, for instance.

19 MR. MAGLADRY: First, is the -- is the -- how
20 -- is the yaw damper engaged all the time or --

21 MR. CHATRENET: Yes, the yaw damper is
22 engaged all the time.

23 MR. MAGLADRY: And you mentioned that the yaw
24 damper does not normally back drive the pedals. Are
25 you aware of any failure modes which could cause the

1 yaw damper to back drive pedals?

2 MR. CHATRENET: Yes. There is one. If there
3 is a jamming of the controls downstream of the -- of
4 the differential additional, if you like, then the
5 motion of the yaw damper would be back driving the
6 rudder pedal in the opposite sign. But in this case,
7 obviously, the rudder would not move at all.

8 MR. MAGLADRY: Could you please repeat that?

9 MR. CHATRENET: In the case of a jamming in
10 the control downstream of the addition of the two
11 orders of the yaw damper and the rudder pedal, if there
12 is a jam here -- we may come back to the -- to the
13 illustration.

14 (Slide)

15 MR. CHATRENET: So, for instance, if at this
16 stage this control is jammed, then the orders coming
17 from the yaw damper would make such that the sum of the
18 motion here plus the motion here is zero because at
19 this stage this cannot be moved because it is jammed,
20 which means that in this case the yaw damper may move
21 the pedal. But in this case, once again, this would
22 not move, which means that the rudder would not move at
23 all.

24 MR. MAGLADRY: And in that case, the -- the
25 pedal would go in the opposite direction?

1 MR. CHATRENET: Exactly. Exactly. At -- on
2 the opposite direction and exactly to the same
3 amplitude that's the motion of the yaw damper.

4 MR. MAGLADRY: Would a -- would the seizure
5 of a bearing in the rudder frame assembly at the
6 differential mechanism, would that also cause a
7 coupling with the yaw damper and pedals?

8 MR. VAN den BOSSCHE: The seizure of the
9 bearing within the differential assembly would jam
10 everything.

11 MR. MAGLADRY: Thank you. Can you talk about
12 the authority limits of the yaw damper in normal
13 operation?

14 MR. VAN den BOSSCHE: Yes. The authority of
15 the yaw damper system is plus or minus 10 degrees of
16 rudder at speeds below 155 knots. And the authority is
17 electronically limited beyond. The authority of the
18 actuator itself start to stop is to plus or minus 12
19 degrees of rudder.

20 MR. MAGLADRY: Could you please display the
21 illustration again which shows the entire system?

22 (Slide)

23 MR. CHATRENET: Want this one?

24 MR. MAGLADRY: I think it's later.

25 (Slide)

1 MR. MAGLADRY: Yes, that one. Could you
2 please -- that illustrates well how the yaw damper
3 authority changes with air speed. Can you just talk us
4 through that illustration? Can you please just talk us
5 through that -- that first box where it says "variable
6 gain"? Dominique -- Mr. Chatrenet, please? Yes. Yes.

7 MR. CHATRENET: This illustrate the maximum
8 authority of the yaw damper as limited by the AVC
9 computer. So it start at 10 degree at low speed and
10 then it reduces as a function -- as an inverse function
11 of the square of the speed.

12 MR. MAGLADRY: And it looks like you've
13 highlighted 250 knots there.

14 MR. CHATRENET: The maximum authority would
15 be around 4.4 degree, around the speed of 250 knots.

16 MR. MAGLADRY: And you chose that speed why?

17 MR. CHATRENET: This is just to illustrate
18 the area where we were on Flight 587.

19 MR. MAGLADRY: Thank you. And please
20 describe the rate limiting function?

21 MR. CHATRENET: The rate limiting function
22 will just limit the output of the yaw damper between
23 plus or minus 39 degree per second.

24 MR. MAGLADRY: And is this approximately what
25 the rudder servos can achieve in terms of rate?

1 MR. CHATRENET: No, the rudder servo can
2 achieve a higher rate of defection.

3 MR. MAGLADRY: And what is that?

4 MR. VAN den BOSSCHE: It's 60 degrees per
5 second when the three systems are active. Which is a
6 normal case by the way.

7 MR. MAGLADRY: I'd like to move on to what
8 monitors are in place for the yaw damper system. So
9 could you please describe the monitors that are in
10 place to make sure that an inappropriate command is not
11 transmitted to the rudder servos?

12 MR. VAN den BOSSCHE: Okay. I'll just get a
13 pointer.

14 (Pause)

15 MR. VAN den BOSSCHE: This slides -- this
16 slide shows the general arrangement of the yaw damper
17 actuator and the two flight augmentation computers.

18 The yaw damper actuator is a duplex system
19 that includes two cylinder and piston assemblies,
20 number one, number two, which are supplied from two
21 independent hydraulic systems.

22 Each of the piston and cylinder assembly is
23 connected to a flight augmentation computer, number
24 one, number two. Each flight augmentation computer
25 includes two different channels. One is a command

1 channel and the other one is a monitoring channel.
2 Each channel received information from its own set of
3 sensors.

4 The function of the command channel is to
5 compute the rudder position with -- which is required
6 for the function, the shwar(ph) damping, for instance.
7 And two, performs the servo loop control of the piston
8 and cylinder assembly.

9 The function of the monitor channel is to
10 make the same sort of computation from its own sensor
11 set. This monitor channel also receive a position
12 information of the piston. And this monitor channel
13 makes a comparison between the position calculated and
14 what -- and the actual position of the piston. And if
15 there is any discrepancy, the system is -- switch offs.
16 This number one system is switch off.

17 Normally, both yaw dampers are simultaneously
18 active and priority is given to number one, owing to a
19 mechanical device. So when number one is switched off,
20 number two automatically takes the relay.

21 This principle is very basic and applies to
22 all the actuators, autopilot for instance.

23 MR. MAGLADRY: Thank you. You mentioned that
24 if a fault is detected by the comparator it will
25 transfer control. Will there also be an oral warning?

1 MR. VAN den BOSSCHE: Yes. There would be a
2 single chime in the cockpit.

3 MR. MAGLADRY: Can you please describe in a
4 little more detail about the -- the function of the
5 comparator?

6 MR. VAN den BOSSCHE: Yes.

7 (Slide)

8 MR. VAN den BOSSCHE: This slide shows a
9 little more detailed description of the same system.
10 The yaw damper actuator is that box which includes
11 several valves. Some of our winding is shown there.
12 And the position transducer which is used for the --
13 could you please -- slide on?

14 (Pause)

15 MR. VAN den BOSSCHE: Thanks. And the
16 position transducer, which is used for servoing the
17 piston.

18 This is the other position transducer which
19 is used for the monitoring function.

20 This is the flight automation computer number
21 one with the command lane and the monitor lane. And
22 this is flight automation computer number two. Here
23 are the sets of sensors which are the initial reference
24 system, the one, two, and three. The air data
25 computers one, two. And the electrical flight control

1 unit, which is a spoiler computer that transmits the
2 hand wheel position.

3 All these sensors are transmitting their
4 information in digital format through airming 249 busses
5 to the computers.

6 Monitoring functions are both software in that
7 area. And hardware in that area.

8 MR. MAGLADRY: I'm not sure that it was
9 clarified but FAC-1 and FAC-2, could you define those
10 terms?

11 MR. VAN den BOSSCHE: Yes. This is a flight
12 augmentation computer number one, which controls the
13 yaw damper servo actuator number one. And this is the
14 flight augmentation computer number two that controls
15 actuator number two.

16 If we go to the detail of the monitoring
17 functions there --

18 (Slide)

19 MR. VAN den BOSSCHE: This "A" -- this "A"
20 square represents the monitoring of the initial -- of
21 the yaw rate that comes from the initial -- systems.
22 This is information coming from the three units. And
23 monitoring of those signals consist in monitoring the
24 digital data transmission. This box looks for flags
25 for no refresh of the computer data.

1 MR. MAGLADRY: What happens if the air -- one
2 of the air data computers sends a higher air speed to
3 FAC-1, for instance?

4 MR. VAN den BOSSCHE: This box also selects
5 the data by a vote with the three of them. The highest
6 is eliminated and the -- and the average is selected.

7 MR. MAGLADRY: The average of the values are
8 selected?

9 MR. VAN den BOSSCHE: Yes. Box "B" I hardly
10 can see it.

11 (Pause)

12 MR. VAN den BOSSCHE: The green box -- is
13 monitoring of the lateral acceleration information.
14 This is also a digital information and the digital
15 transmission is monitored the same way.

16 "C" monitors the yaw rate.

17 Again, monitoring of the digital
18 transmission.

19 "E" monitors -- "E" monitors the air speed.
20 It's also a monitoring of the digital transmission.

21 And the box "F" is the actual calculation of
22 the surface order, surface position.

23 All that is digital. To this point, there is
24 a digital to analog converter and all the rest is
25 analog. The computed signal, the computed rudder

1 position from this command lane is sent to a voter.
2 The other computed position is sent to the same voter.
3 And the two positions are voted with zero, which means
4 that the highest is eliminated. And the final position
5 -- the final order there is the lowest of both.

6 There's a comparator here, "C1", which
7 compares the information calculated there --

8 (Pause)

9 MR. VAN den BOSSCHE: Which compares the --
10 the position calculated there and the output of the
11 voter. If there is a discrepancy higher than two
12 degrees for a time longer than two seconds, the system
13 is identified as failed.

14 The same hardware comparison is performed
15 there between the signal calculated by this lane, the
16 monitoring lane, and the output of the voter.

17 Now, the second monitoring function deals
18 with the power loop, and this is a comparison between
19 this position, which is a calculated position -- which
20 is a calculated position of the rudder and the actual
21 position as measured by this transducer on the
22 actuator.

23 The position -- the position computed the
24 other -- excuse me -- is going through some kind of a
25 simulation model of the actuator. And the signal at

1 this point is supposed to be exactly what -- the
2 position of the unit. So the comparison takes place in
3 both lanes at this time. And if a discrepancy exceeds
4 two degrees for a time longer than 100 milliseconds,
5 the system is identified as failed.

6 MR. MAGLADRY: Thank you. Now I'd like to
7 move to some observations about the flight data
8 recorder information.

9 Mr. Annibale, could you please display
10 Exhibit 13-A, page 79?

11 (Pause)

12 MR. MAGLADRY: Please bear with us while we
13 get that displayed.

14 MR. CHATRENET: Page 79?

15 (Slide)

16 MR. MAGLADRY: There we have it.

17 CHAIRMAN CARMODY: I'm sorry. Did we -- Mr.
18 Magladry, did you identify the exhibit itself?

19 MR. MAGLADRY: Yes. It's 13-A.

20 CHAIRMAN CARMODY: Thank you.

21 MR. MAGLADRY: Page 79.

22 CHAIRMAN CARMODY: Okay. Thanks.

23 MR. MAGLADRY: And this presents flight data
24 from the accident flight. It provides rudder pedal
25 information and rudder surface information.

1 Can you please make any comments with regard
2 to could the yaw damper -- the malfunction of the yaw
3 damper created -- or normal operation of the yaw damper
4 caused these motions?

5 MR. CHATRENET: So the -- as we said earlier,
6 the design principle of the yaw damper, thanks to the
7 monitoring function, allows to consider as extremely
8 improbable any -- or runaway of the yaw damping
9 function.

10 The maximum authority of the yaw damper in
11 this vonger(ph) speed is only 4.4 degree, which is less
12 than the rudder defection which is shown in this graph.

13 The yaw damper activity, as it said, would
14 not move the pedal in other cases when the rudder would
15 not move. So as the rudder is shown to move during
16 this time period, it excludes a rudder jamming, which
17 means that the -- in this circumstances, the yaw damper
18 could not move the pedals.

19 Moreover, we have checked also that during
20 the flight control checks prior to the takeoff, the yaw
21 damper is working as per design and is just showing the
22 turn coordination we have at this stage. And also
23 during the alignment of the aircraft with the runway,
24 there is some yaw rate because the aircraft is turning
25 to the runway. And at this stage, we see also on the

1 traces that the yaw damper is performing as per design
2 during this period of time.

3 MR. MAGLADRY: So as -- you're saying as we
4 saw in the simulation when Mr. Benzon -- that Mr.
5 Benzon presented, we saw while taxiing out the -- the
6 rudder moved and flight data traces did not show --

7 MR. CHATRENET: Yes.

8 MR. MAGLADRY: -- pedal movement and --

9 MR. CHATRENET: Yes. And -- and it's -- it's
10 pretty visible on what we have been -- what we have
11 been shown. The rudder pedal does not move, but we see
12 the rudder pedal moving according to the yaw rate when
13 the aircraft is aligning with the runway.

14 MR. MAGLADRY: So this indicates there was no
15 jam between the rudder pedal --

16 MR. CHATRENET: Yes.

17 MR. MAGLADRY: -- and the --

18 MR. CHATRENET: Yes.

19 MR. MAGLADRY: -- yaw damper --

20 MR. CHATRENET: Yes.

21 MR. MAGLADRY: -- linkage? And again, the
22 maximum authority at this particular air speed, which
23 is around 250 knots, is four degrees?

24 MR. CHATRENET: Is only 4.4 degree.

25 MR. MAGLADRY: Thank you. That concludes my

1 comments on the yaw damper. I'd like to move on to the
2 yaw autopilot.

3 Mr. Chatrenet, can you please describe the
4 operation of the yaw autopilot system?

5 MR. CHATRENET: So first the -- the autopilot
6 is engaged and disengaged at pilot discretion. And
7 when the autopilot is not engaged, the associated
8 autopilot servo actuator are not clutched to the
9 mechanical linkage of the control surface or of the
10 control.

11 Now, when the autopilot is engaged, then the
12 servo actuators move the whole linkage between the
13 pilot controls and the actuators.

14 The pilot can always take over control of the
15 aircraft either by disconnecting or by -- by overriding
16 the autopilot.

17 On the yaw axis, we have to bear in mind that
18 on the A-300-600-R autopilot, the yaw axis is only
19 active on rudder when the slats are extended and the
20 autopilot is engaged, which means that as soon as the
21 slats are retracted the autopilot is no longer engaged
22 on the yaw axis even if the autopilot is engaged.

23 And we have evidence that all along the
24 Flight 587 the autopilot was never engaged.

25 (Pause)

1 MR. MAGLADRY: Do you have an illustration of
2 the autopilot actuator system?

3 (Pause)

4 (Slide)

5 MR. VAN den BOSSCHE: This is the actuator.

6 MR. MAGLADRY: Okay. This is Exhibit 9-C,
7 page two?

8 MR. VAN den BOSSCHE: Yes. This is the same
9 picture.

10 MR. MAGLADRY: Could you show me how the --
11 the autopilot, as you say, clutches to the output?

12 MR. VAN den BOSSCHE: All right. So first,
13 this autopilot servo actuator is dual and two of this
14 assembly, two similar assemblies, which are both
15 driving the same output lever, which is there. The
16 output lever is connected to the mechanical linkage
17 that drives the autocontrol.

18 The autopilot -- both autopilot could be
19 active simultaneously, and there is a mechanical device
20 that gives priority to number one.

21 When autopilot is not engaged, the unit is
22 active. I mean that the piston is -- which is there is
23 servoed, that the movement of the piston is not
24 transmitted to the output because the clutch mechanism
25 is not on.

1 The clutch mechanism consist in this lever,
2 which has got a V-shaped cam in it which can be pushed
3 against this roller when the cylinder is moved upwards.
4 It is shown in a detached configuration when the roller
5 is in contact with the V-cam. It's engaged, it's
6 clutch, and the movement of the piston can be
7 transmitted to the output.

8 This engagement cylinder is controlled by a
9 solenoid valve, which is that one. And when the
10 solenoid valve is -- which is the configuration which
11 is shown on this picture, the pressure coming from the
12 input goes to this chamber and pushes the piston
13 upwards. It is clutched.

14 MR. MAGLADRY: So until that occurs, the
15 autopilot is not -- cannot make any commands to the
16 rudder?

17 MR. VAN den BOSSCHE: No. The movement of
18 the piston cannot be transmitted to the rudder.

19 MR. MAGLADRY: And that does not incur --
20 that does not occur until you engage the autopilot?

21 MR. VAN den BOSSCHE: Sure. Yes.

22 MR. MAGLADRY: What failure mode could occur
23 to engage the clutch if the auto pilot was not engaged?

24 MR. VAN den BOSSCHE: I may show you what is
25 first the monitoring function of that system. So let

1 me first tell you that -- in addition to this
2 engagement solenoid valve, there is another valve which
3 is a main valve which purpose is to turn off the
4 hydraulic upstream of that one and two -- unit.

5 MR. MAGLADRY: This would be -- I guess this
6 would be a good time for you to describe the monitoring
7 functions of that clutch.

8 MR. VAN den BOSSCHE: Picture three, please.

9 (Slide)

10 MR. VAN den BOSSCHE: So this is a busy
11 picture. It shows here the servo actuator in less
12 detail than it was shown before. But you can identify
13 the clutch lever, the piston, the output, the clutch
14 solenoid valve, and the main solenoid valve.

15 I did not mention that the position of the
16 lever was detected by a pair of switches which are
17 shown there.

18 This is the flight control computer which is
19 associated with this particular module of the autopilot
20 servo actuator. And the computer makes the actuation
21 of the engagement signal from the cockpit and makes the
22 acquisition of the switch signal.

23 These signals are processed both by the
24 monitor lane, which is that one, and by the control
25 lane, which is that one. This is a two-lane system

1 similar to what I've shown for the yaw damper.

2 (Slide)

3 MR. VAN den BOSSCHE: Okay. Thank you.

4 There are two types of monitoring functions
5 which are hardware. This is the hardware monitoring
6 which is performed by the command lane. This is the
7 hardware monitoring function performed by the monitor
8 lane. And there is also some software monitoring
9 functions.

10 This logic condition 1-N is generated when
11 the signal from one switch do not correspond to the
12 signal from the engagement lever. And when 1-N is
13 generated, these open this switch, which opens the
14 circuit to the clutch valve.

15 A similar logic generates the condition 1-C
16 here in the other lane. And this logic condition opens
17 another switch that opens a circuit to the other wire
18 of the clutch valve.

19 And there is a third logic condition which is
20 software-calculated, there, which is logic 2-C, which
21 acts on the main valve if necessary. This one is
22 mainly used for detecting inadvertent engagement of the
23 clutch.

24 MR. MAGLADRY: Okay. So there appears to be
25 a number of levels of redundancy of detection. If you

1 have -- if you do not have the autopilot engaged but
2 yet the actuator is the clutch to the output, this will
3 be detected from what you just described. And what
4 will be the result of a detection?

5 MR. VAN den BOSSCHE: The result of the
6 detection will be first to passivate the servo actuator
7 and to disengage the autopilot.

8 MR. MAGLADRY: Will there be a warning
9 associated with this?

10 MR. VAN den BOSSCHE: Yes, there would be.

11 MR. MAGLADRY: And I can't recall, and I'm
12 sorry, did you note whether the autopilot was engaged
13 during the -- at any point during this flight?

14 MR. VAN den BOSSCHE: No. The pilot was not
15 -- has never been engaged during the flight.

16 (Pause)

17 MR. MAGLADRY: What would happen if the
18 autopilot failed to engage from a previous flight?
19 Would the -- would the pilots be able to detect that?

20 MR. VAN den BOSSCHE: This would have been
21 seen when the aircraft was on the ground. The controls
22 would have been stiff, held by the autopilot servo
23 actuators.

24 MR. MAGLADRY: How -- how -- how stiff would
25 they be? And would they -- would this be something the

1 pilot would detect when he's trying to do his control
2 sweep?

3 MR. VAN den BOSSCHE: Well, if the pilot
4 wanted to make -- override the servo actuator, he would
5 have to apply a load on the pedal which would be of
6 about 150 pounds.

7 MR. MAGLADRY: Could we please display
8 Exhibit 9 -- 9-C, page three?

9 (Slide)

10 MR. MAGLADRY: Can you please describe in
11 this illustration -- this is the -- this is the
12 autopilot system actuators and how they're coupled
13 together. Can you please describe how the pilot can
14 override these actuators?

15 MR. VAN den BOSSCHE: May I have the pointer?

16 (Pause)

17 MR. VAN den BOSSCHE: The output lever, which
18 is actually this lever, includes a detent a spring
19 system which consists in a cam, that V-shaped part
20 there; a rudder which is pushed by a spring; and the
21 force necessary to override which is to disengage the
22 rudder from the V-shaped cam is that force of about 150
23 pounds at the pedals.

24 MR. MAGLADRY: Okay. So I guess in summary
25 if the autopilot for some reason did not engage from a

1 previous flight and it was not detected and the pilot
2 attempted to do a flight control sweep as was observed
3 on the ground prior to takeoff, he would experience an
4 additional 150 pounds to override this autopilot
5 actuator and move -- move the rudders?

6 MR. VAN den BOSSCHE: Yes.

7 MR. MAGLADRY: Is that true?

8 MR. VAN den BOSSCHE: The control would have
9 been reported to be very stiff and they won't have
10 takeoff.

11 MR. MAGLADRY: Okay. Thank you. Can you
12 please describe any in-service events for both the yaw
13 damper and yaw autopilot that you think may be relevant
14 to this accident investigation -- may or may not be
15 relevant? Yes?

16 (Pause)

17 MR. VAN den BOSSCHE: Sixty-five, please.

18 (Slide)

19 MR. VAN den BOSSCHE: So this is an event
20 which -- which is linked with the yaw damper servo
21 actuator and the flight augmentation computer. And
22 what happened is that the yaw damper has shown a
23 runaway on the ground which resulted in a rudder
24 offset. And this condition has been identified during
25 the flight control check.

1 The cause for this failure has been
2 identified as a flight augmentation computer electronic
3 bolt failure when applying a modification. And this
4 defect was intermittent and has not been seen at the --
5 accident -- after the mode has been embodied.

6 The yaw damper runaway on the ground has not
7 been detected as per design because on the ground the
8 power look monitoring is not active.

9 MR. MAGLADRY: So this monitoring you
10 described previously in the yaw damper, it's only
11 active after the airplane --

12 MR. VAN den BOSSCHE: It's --

13 MR. MAGLADRY: -- is in the air?

14 MR. VAN den BOSSCHE: Yes, it is.

15 Corrective action, no corrective action has
16 been defined. It has been confirmed that the pre-
17 flight check was appropriate for identifying the defect
18 and it worked.

19 This is the in-service failure mode of the
20 yaw damper that I have. Would you like autopilot?

21 MR. MAGLADRY: Please.

22 (Slide)

23 MR. VAN den BOSSCHE: So the event was
24 uncommanded rudder -- rudder oscillations during
25 approach. And this -- two different scenarios have

1 been experienced this is the first one.

2 The first one was a combination of two
3 failures. First, a clutch solenoid valve failure. It
4 was a failure to declutch caused by some contamination,
5 some pollution of the solenoid valve. Plus, another
6 failure which was a cross-connection between the two
7 main valves. I told you that the servo actuator was a
8 dual unit. It has got two main valves. And it
9 happened that the wires between the main connector and
10 the solenoid valve were cross-connected. And
11 therefore, the monitoring function that has been shown
12 which switch off the main valve was not about to do it
13 because it was addressing the wrong valve.

14 So this was the first failure mode which was
15 really failure to disengage.

16 Another failure mode that resulted in
17 uncommanded rudder oscillations was linked to the servo
18 valve, to the electronic servo valve which has a high
19 flow gain around zero.

20 Corrective actions have been launched.
21 First, mandatory inspection of all the actuators, three
22 axis, spare actuators, mandated by analysis directive.
23 A modification of the acceptance test procedure to make
24 sure that the cross-connection would be detected.
25 Modification of the aircraft maintenance manual procedure

1 for the same objective. And modification of the test procedures
2 after installation of a autopilot servo actuator.

3 At the manufacturer a quality survey has been
4 launched, and the manufacturing process of the solenoid
5 valves has been modified.

6 Similarity with Flight 587, first no -- no
7 oscillations. The events before resulted in
8 oscillations plus or minus three degrees with a period
9 of several seconds, -- like that, for the first case.
10 And plus or minus one degree with a frequency of six
11 hertz for the second case. So nothing similar.

12 Evidence that the aircraft took off with the
13 autopilot not -- not engaged and in declutch condition.

14 During the flight, the autopilot was never engaged.
15 All these monitoring actions were performed on this
16 aircraft.

17 The solenoid valve cross-connection was to be
18 checked on the accident airplane servo actuator but
19 this has not been possible due to the condition of the
20 unit, so this has not been checked formally.

21 And of course, if the servo actuators had
22 given an order, the pilot would have react in all -- in
23 the opposite direction.

24 MR. MAGLADRY: A theoretical scenario here.
25 If the autopilot -- although the autopilot was

1 established to not be engaged, if for some reason there
2 was a spontaneous failure mode that clutched the
3 autopilot actuator, could the accident flight have
4 experienced similar oscillations?

5 MR. VAN den BOSSCHE: No, I don't think so.

6 MR. MAGLADRY: And -- and why is that? What
7 -- what is different about the flight configuration of
8 this airplane versus the -- Miami airplane?

9 MR. VAN den BOSSCHE: Because monitor
10 functions would have operated on this -- on this unit.

11 Assuming that there was no cross-connection, and I'm
12 saying that there was no cross-connection because the
13 unit -- the aircraft has been inspected for that.

14 MR. MAGLADRY: Are you aware of what was
15 causing these oscillations on this flight?

16 MR. VAN den BOSSCHE: The -- you're talking
17 about the in-service event?

18 MR. MAGLADRY: Yes.

19 MR. VAN den BOSSCHE: Yes. What was causing
20 the oscillation was the abnormal closed-loop system
21 which resulted from the unit being in synchronization
22 mode and being clutched.

23 MR. MAGLADRY: This airplane was on approach
24 with -- with -- and its flaps were down, I presume?

25 MR. VAN den BOSSCHE: Yes.

1 MR. MAGLADRY: And the accident airplane --

2 MR. VAN den BOSSCHE: Had flaps retracted

3 with --

4 MR. MAGLADRY: Flaps retracted --

5 MR. VAN den BOSSCHE: -- logic condition

6 which inhibits the yaw servo actuator.

7 MR. MAGLADRY: I'm sorry?

8 MR. VAN den BOSSCHE: The -- when the flaps
9 are retracted, the yaw autopilot servo actuator is
10 inhibited. This is a logic condition.

11 MR. MAGLADRY: So even if for some reason it
12 was cross-connected and the autopilot spontaneously
13 engaged, the commands would not have reached the
14 actuator because the flaps were up?

15 MR. VAN den BOSSCHE: Yes. That's flaps yes.

16 MR. MAGLADRY: Do you have any other in-
17 service events concerning the yaw autopilot?

18 MR. VAN den BOSSCHE: No.

19 MR. MAGLADRY: Okay. I guess that concludes
20 my discussion of the yaw autopilot. I'd like to move
21 on to some questions concerning rudder feel and trim.

22 Mr. Annibale, could you please display
23 Exhibit 9-F, page four?

24 (Slide)

25 MR. MAGLADRY: This is an illustration of the

1 rudder frame assembly, and it points out the artificial
2 feel and trim unit and rudder trim actuator.
3 Certainly, more components that control this system.
4 Could you please describe the operation and purpose of
5 this -- the artificial feel and trim system?

6 MR. CHATRENET: So the -- the purpose of the
7 artificial feel is through the -- the spring which are
8 in it to provide basically two function. The first one
9 is of usually to signal to the pilot increases
10 defection on the rudder command. And the second
11 function is to bring back the rudder deflection to zero
12 when the -- when any force is released from the rudder
13 pedal.

14 So there is a centering function and there is
15 an artificial feel function provided by these springs.

16 MR. MAGLADRY: How does the rudder trim
17 actuator work?

18 (Slide)

19 MR. VAN den BOSSCHE: There is a trim
20 actuator. It is an electromechanical actuator which
21 drives a -- an irreversible screw jack which -- which
22 changes the zero load position of the springs.

23 MR. MAGLADRY: And if this actuator were to
24 fail and drive the rudder trim actuator, how fast would
25 it move --

1 MR. VAN den BOSSCHE: The maximum rate of the
2 rudder trim actuator is 1.2 degrees per second. So if
3 it would have failed and drive the control, its
4 signature would have been a 1.5 degree per second
5 movement.

6 MR. MAGLADRY: And the rates of the rudder
7 change in the accident flight, have you studied the
8 approximate rate of change of rudder position in the
9 accident flight?

10 MR. CHATRENET: They are -- they are far in
11 excess of 1.2 degree per second.

12 MR. MAGLADRY: Are there any in-service
13 events that are relative -- relevant to the accident
14 investigation?

15 MR. VAN den BOSSCHE: Fifty-five, please.

16 (Slide)

17 MR. VAN den BOSSCHE: So there has been
18 several incidents which resulted in uncommanded rudder
19 trim movement. And it happened that right at the
20 beginning, the logic was a little different. And in
21 the early incidents, trim runaway remained hidden when
22 the autopilot was engaged. And -- the autopilot
23 disconnect resulted in a jerk of the rudder control to
24 reach the trim position.

25 Several causes have been identified. The

1 first cause was -- inadvertently moved a rudder trim
2 knob.

3 Can you show 57, please?

4 (Slide)

5 MR. VAN den BOSSCHE: The origin -- original
6 shape of the knob was at one, and this was prone to be
7 moved by objects or documents lying on the center
8 pedestal. This could have been the cause of some
9 events.

10 Fifty-five, again.

11 (Slide)

12 MR. VAN den BOSSCHE: Another source has been
13 the interference between the knob and the mounting
14 plate which resulted in a lack of clearance and a jam
15 of the knob when operated.

16 Fifty-seven, again.

17 (Slide)

18 MR. VAN den BOSSCHE: This is a mounting
19 plane. This is a trim switch. This is the trim knob.
20 And dimensions of this components right at the
21 beginning necessitated an adjustment. And if the
22 adjustment was not correctly performed or was changed
23 for any reason, there could be a lack of clearance
24 between the knob and the mounting plate, resulting in a jamming.

25 Fifty-five, again.

1 (Slide)

2 MR. VAN den BOSSCHE: There has been a case
3 of reset out of neutral due to a wrong trim indication
4 at the trim indicator. And there has been switch
5 failures as well.

6 Corrective actions were -- were identified as
7 mandatory modifications. So the trim geometry has been
8 changed to what I've shown on the slide before.

9 Dimension of the switch shaft and of the knob
10 have been changed to make impossible the lack of
11 clearance with no adjustment.

12 The rudder trim has been inhibited when the
13 autopilot is active to prevent otherwise hidden by the
14 autopilot operation.

15 And a third switch stage has been added to
16 prevent one failure of the switch resulting in the --
17 in the runaway.

18 Similarities with Flight 587, first, as I
19 said before, there is no evidence of a one point degree
20 per second rudder movement. The autopilot was never
21 engaged. The slats were retracted, by the way. All of
22 the mandatory modifications were incorporated. And if
23 there had been a trim unaware the pilot reaction would
24 have been opposite.

25 MR. MAGLADRY: Okay. I have no questions.

1 CHAIRMAN CARMODY: Mr. Magladry, I'm
2 wondering if this would be a good point for us to take
3 a short break. I think the witnesses have been under
4 questioning for over an hour and I think we could use a
5 little break.

6 Do you have just one more item you want to
7 finish before we do that or is this a good time for
8 you?

9 MR. MAGLADRY: I have two questions with
10 regard to the feel system and then we'd move on to the
11 rudder travel limiter.

12 CHAIRMAN CARMODY: All right. Well, do you
13 want to do the two questions? And then we'll go to the
14 last.

15 MR. MAGLADRY: Mr. Annibale, could you please
16 display Exhibit 9-F, page six?

17 (Slide)

18 MR. MAGLADRY: Mr. Chatrenet, can you please
19 describe this illustration?

20 MR. CHATRENET: Okay. So the -- this shows
21 the basic characteristics of forces versus displacement
22 which are provided by the springs in the artificial
23 feel unit.

24 So first, you see around zero deflection what
25 we call the threshold or breakout force. This is

1 roughly about 22 pounds. This breakout force has two
2 objectives. The first one is obviously to prevent any
3 inadvertent input on the control on the rudder pedals
4 that might result from the motion of the pilot and so
5 on.

6 MR. MAGLADRY: So you must push with 22 and a
7 half pounds before the pedal will start to move?

8 MR. CHATRENET: Yes, exactly. Exactly. We
9 must push this amount of force before there is any
10 perceptible displacement.

11 So the first objective is to prevent any
12 inadvertent input on the rudder control. And the --
13 this will be probably discussed or developed later on,
14 but this is an appropriate force in order to avoid this
15 kind of unintentional input. And we have some guidance
16 and some evidence that this is an appropriate force.

17 The second role of the breakout force is to
18 provide a positive return to zero deflection or
19 actually to the trim deflection whenever the pilot
20 would release the pedal. So it should be very simple
21 for the pilot to come back to the zero deflection
22 position or to the trim position just by releasing the
23 feet from the pedal. And thanks to the breakout, this
24 will be positive and back to this -- to this position.

25 So this is for the breakout forces about 22

1 degrees.

2 Now, further to these forces, you have a
3 gradient of force versus rudder deflection from the
4 breakout to the maximum force. And this is in order to
5 provide the pilot with the feedback of what are the
6 control inputs on this axis.

7 At this stage, to get a better understanding,
8 we must introduce some kind of a notion of closed loop
9 control inputs. What does it mean, closed loop control
10 inputs. It mean that it's a continuous tuning of the
11 control inputs made by the pilot in order to -- to
12 obtain the desired outcome of the aircraft motion.

13 This is the basic I would say piloting
14 technique, closed loop control input by opposition to
15 open loop control input for which the pursued objective
16 is to get a given deflection and generally a maximum
17 deflection.

18 So coming back to the gradient of forces
19 beyond the breakout force, this is designed in order to
20 provide precise control capability in case of closed
21 loop control input only. This has nothing to see with
22 open loop control input.

23 And for this, we must design the gradient of
24 force in order to allow the pilot to get a precise
25 control of the aircraft.

1 This is a part of the design of the flight
2 control system which is main -- made in very close
3 relationship with the pilots at the design stage, at
4 the testing stage, whether on ground, on our iron bars,
5 on our simulators, and later in flight. And this is
6 obviously one of the characteristics which contribute
7 to the handling qualities of the aircraft and which are
8 even discussed with the pilots community later on after
9 the entering to service of the aircraft.

10 CHAIRMAN CARMODY: Mr. Magladry, excuse me.
11 I'm going -- I'm going to stop you now.

12 MR. MAGLADRY: Yes.

13 CHAIRMAN CARMODY: We have a large number
14 of family members who have just arrived and they want
15 to come in. So I think a break would be appropriate
16 now.

17 May I ask any NTSB employees who are in the
18 audience to please return to your offices and watch
19 from there because we may need the extra seats.
20 Certainly come back later if there is space, but the
21 families have come down to hear this and I don't want
22 them to be held out any longer.

23 So let's -- let's come back at about 10 of
24 12. Thank you so much. Sorry to break it off, but
25 we'll return to it.

1 (Brief recess)

2 CHAIRMAN CARMODY: Mr. Magladry was
3 questioning the witnesses, and I believe you were not
4 quite finished, Mr. Magladry. So please resume.

5 Please -- please come in from the doors and
6 close them. Thank you.

7 MR. MAGLADRY: Yes. I'd like to begin again
8 with the questioning concerning the field
9 characteristic curve.

10 Mr. Annibale, could you display that, please?

11 (Slide)

12 MR. MAGLADRY: Mr. Chatrenet, you described
13 what this illustration presents. And the breakout
14 forces for the pedals are around 22 pounds. And it
15 appears that to achieve maximum deflection of 30
16 degrees of rudder, it would require approximately 75 --
17 67 pounds.

18 My question is, how does Airbus determine
19 this range of forces?

20 MR. CHATRENET: Actually, I was not in charge
21 of flight control at the time the design was made. But
22 at least I can tell you about what I've heard about the
23 reasons.

24 We -- we had a good record of good handling
25 qualities and good perception when we designed the A-

1 300-B2-B4, which was the aircraft before the A-300-600.
2 And of -- of relevance were that on this aircraft the
3 control forces in roll and the control forces in yaw
4 were perfectly consistent and matching together. This
5 is important. I'm not a pilot, but I can understand
6 that from a pilot point of view roll and yaw axes are
7 related. And it is important that the forces on the
8 roll axis and the forces on the yaw axis must be well
9 balanced, well harmonized.

10 This was the case on the B2-B4, and we had a
11 good record of pilot satisfaction in terms of
12 consistency between the two axes.

13 We had nevertheless a suggestion coming from
14 the pilots that the roll control forces might be a bit
15 lower in order to allow for more precise or ease of
16 piloting. And it was at this state -- at this stage a
17 general tendency to go to lower forces, lower forces
18 because on the control point of view it allowed for
19 more precise control of the flight path.

20 So we decided when going from the A-300-B2-B4
21 to the A-300-600 to lower the roll forces by roughly
22 something like 30 percent. And this was made possible
23 thanks to the introduction of the electrical control of
24 the spoilers which reduce the amount of friction in the
25 control and therefore which allowed for less control

1 forces on the roll axis.

2 And we have basically kept the same
3 consistency that we had between the roll and yaw axes
4 and which gave satisfaction on the B2-B4 aircraft, and
5 we kept the proportion for the A-300-600. This is how
6 we have determined the maximum forces for the rudder
7 feel system of the A-300-600-R.

8 MR. MAGLADRY: If I understand you correctly,
9 the -- on the -- you -- you commented on the roll
10 system. Is it true also that the A-300-600 rudder
11 pedal forces are less proportionally than the B2-B4?

12 MR. CHATRENET: Yes. By -- the proportion of
13 the reduction of the roll efficiency.

14 MR. MAGLADRY: Thank you. Are there any
15 certification requirements that drive the determination
16 of your rudder feel forces?

17 MR. CHATRENET: The -- the only certification
18 requirement we have only stipulate maximum level of
19 forces.

20 MR. MAGLADRY: And do you -- do you recall
21 what those are? What the maximum forces are?

22 MR. VAN den BOSSCHE: On the -- on the
23 pedals, the -- guidelines give us a maximum of 56
24 decanewtons, which is 120 pounds. This was the maximum
25 given by the guideline.

1 MR. MAGLADRY: So you're saying that it can't
2 exceed 120 pounds approximately to achieve full
3 displacement of the rudder is the only certification
4 requirement relevant to this.

5 Okay. I'd like to proceed with some
6 questions about the rudder travel limiter design.

7 MR. CHATRENET: Okay.

8 MR. MAGLADRY: Mr. Annibale, can you please
9 display Exhibit 9-D, page two?

10 (Slide)

11 MR. MAGLADRY: This is an illustration
12 schematic of the rudder travel limiting system on the
13 A-300-600. Can you please walk us through this
14 illustration, Mr. Chatrenet?

15 MR. CHATRENET: Maybe Mr. Van den Bossche
16 will --

17 MR. MAGLADRY: Mr. Van den Bossche?

18 MR. CHATRENET: -- than me.

19 MR. VAN den BOSSCHE: May I use our own
20 picture? Therefore I will be able to use a pointer.

21 (Pause)

22 MR. VAN den BOSSCHE: So this is about the
23 same.

24 The variables stop consist in -- first in
25 this lever, which is connected to the output of the

1 summing mechanism which I have talked about before.
2 This lever is hinged around a fixed point, and the
3 other end of the lever is connected to the linkage to
4 the servo actuators.

5 This lever has got some kind of a roller here
6 which is -- which however is limited by the V-shaped
7 cam of this arm. This arm is hinged on structures
8 there and can be moved by this actuator back and forth.
9 And it also drives the position transducers.

10 When the V-cam is shown in this position, the
11 travel of this lever is relatively large, from this
12 point to that one. And when the V-cam is moved to the
13 right, the travel is limited to this -- is limited to
14 this reduced stroke. This the low speed, this is the
15 high speed.

16 The actuator includes a screw, an
17 irreversible screw, that is such that when a load is
18 applied on the -- on the cam, the cam is not pushed
19 back by the pilot load.

20 MR. MAGLADRY: Is it true to describe this
21 system as a -- a system which limits the pedals in
22 order to limit the amount of rudder restriction?

23 MR. VAN den BOSSCHE: No. This limits the
24 sum of the pedal movement plus the yaw damper movement.

25 MR. MAGLADRY: So it's the combination of the

1 two?

2 MR. VAN den BOSSCHE: Yes.

3 MR. MAGLADRY: The yaw damper, which is
4 always active, and the -- and the --

5 MR. VAN den BOSSCHE: Yes.

6 MR. MAGLADRY: -- input provided from the
7 pedals are summed and then it is restricted at this
8 point?

9 MR. VAN den BOSSCHE: Yes.

10 MR. MAGLADRY: And those -- those plots above
11 noted as "feel limitations computer," this is the --
12 can you please describe that?

13 MR. VAN den BOSSCHE: This is the low which
14 has been explained earlier. This is a limitation in
15 rudder degrees versus air speed. From zero to 165
16 knots, the maximum rudder movement is 30 degrees. And
17 then it is reduced according to the slope to a minimum
18 of point -- 3.5 degrees at 395 knots.

19 MR. MAGLADRY: Why do we limit rudder
20 deflection at higher air speeds?

21 MR. CHATRENET: So, at this stage I may
22 answer. From a handling quality point of view, the
23 main use of the rudder or the big deflection needed
24 from the rudder are needed at low speed. It is for --
25 some cross wind landing, which is usually at low speed,

1 or for compensating the asymmetry from an engine
2 failure. And the engine's first asymmetry is also at
3 its biggest value when the aircraft is flying at low
4 speed, which means that when the rudder is designed in
5 order to provide this maximum rudder deflection at low
6 speed, the rudder which is needed at higher speed is
7 smaller. And on our Airbus aircraft, the border is set
8 roughly at 165 knots or 170 knots.

9 At higher speed than this 165 knots, the
10 maximum rudder deflection is not necessary. Therefore,
11 the variable stop is there to limit the rudder
12 deflection. And this limit has been set according to
13 handling qualities consideration.

14 Mainly, the curves are low, the rudder
15 deflection which is sufficient to provide, first, the
16 rudder deflection which is needed to compensate
17 statically for an engine failure and, second, to
18 provide for yaw damper activity on both sides of the
19 static rudder deflection needed for compensating an
20 engine failure. This is how the curve is determined at
21 the speed higher than the 165 knots speed.

22 MR. MAGLADRY: So for instance, I notice you
23 chose one point there at 9.3 -- the rudder is limited
24 to 9.3 degrees at what appears to be 250 knots.

25 MR. CHATRENET: Yes.

1 MR. MAGLADRY: And as you have done the
2 analysis, that is -- that is the amount of rudder you
3 need to compensate for an engine out at -- at 250 knots
4 plus --

5 MR. CHATRENET: Plus what is needed for the
6 yaw damper to operate on both sides of the static
7 rudder deflection.

8 MR. MAGLADRY: Is it exactly 9.3 or is it
9 something less than that value? Is there a margin
10 you've included?

11 MR. CHATRENET: The margin is basically what
12 is needed for the yaw damper to -- to operate.

13 MR. MAGLADRY: Is this method driven by a
14 certification requirement that -- that you have the
15 ability to compensate for engine out at this air speed
16 plus yaw damper? Or is that something -- a formula
17 that Airbus derived?

18 MR. CHATRENET: No, it is -- these are basic
19 design principle to -- to allow both capability to
20 compensate the engine failure and still yaw damper
21 activity.

22 MR. MAGLADRY: Is this -- the yaw damper
23 provides turn coordination and dutch roll and engine
24 out compensation. Which aspect -- is it the engine out
25 compensation that --

1 MR. CHATRENET: No. The engine out
2 compensation coming from the AVC computer from the yaw
3 damper is only working during a go-round with the
4 autopilot engaged which is at very low speed. So at
5 higher speed, at speed around 165 knots and above, it
6 is only for dutch roll damping and turn coordination.
7 And --

8 MR. MAGLADRY: So --

9 MR. CHATRENET: -- turn coordination
10 basically is no longer active, if you like, at speed
11 above 250 knots. So the turn coordination is working
12 between 165 knots and 250 -- and lower speed as well.

13 MR. MAGLADRY: Okay. So if I understand this
14 correctly, it's both at -- that profile is the sum of
15 what you would need for -- to compensate for an engine
16 out at a particular air speed --

17 MR. CHATRENET: Yes.

18 MR. MAGLADRY: -- plus if you were to perform
19 a coordinated turn?

20 MR. CHATRENET: Yes. Plus a capability to --
21 to damp the dutch roll -- of the aircraft in
22 turbulence.

23 MR. MAGLADRY: And how big is that? Can you
24 put -- can you quantify how much rudder is necessary
25 for a turn coordination --

1 MR. CHATRENET: Yes.

2 MR. MAGLADRY: -- at those air speeds?

3 MR. CHATRENET: Precisely it would be
4 difficult just from memory. We have made a study. We
5 have a technical note which describe and which
6 substantiate the -- the design of this curve. And this
7 could be given for the record if needed.

8 To give you, I would say, half figures, when
9 -- when the TLU is giving basically 10 degrees, there
10 is something like around seven degrees needed for
11 engine out compensation and three degree for yaw damper
12 activity. But I would prefer to give the exact figure
13 and the actual figure through our technical note that
14 might be provided for the record.

15 MR. MAGLADRY: Madam Chairman, is it -- would
16 it be acceptable for him to present the data from a
17 technical note that's not currently an exhibit?

18 CHAIRMAN CARMODY: There's not an exhibit
19 available to the rest of the parties?

20 MR. MAGLADRY: Do you have an illustration --

21 MR. CHATRENET: No, not -- not available
22 here, but later on during the -- during the public
23 hearing we could -- we could give you a copy of this
24 note.

25 CHAIRMAN CARMODY: Is it something that could

1 be reproduced now? If you have a copy, perhaps we
2 could have it reproduced.

3 MR. CHATRENET: Not -- not right now but --

4 CHAIRMAN CARMODY: Oh.

5 MR. CHATRENET: -- today or tomorrow it could
6 be done.

7 CHAIRMAN CARMODY: What -- I'm sorry. What
8 is it you're presenting then? I thought you were
9 presenting it now but you have no copy?

10 MR. MAGLADRY: He's presenting it from memory
11 and --

12 MR. CHATRENET: Yes.

13 CHAIRMAN CARMODY: All right. I see, I
14 see.

15 MR. MAGLADRY: So to summarize, I guess,
16 Airbus has -- has chosen this formula not because of
17 the certification requirement that -- that it's the sum
18 of the -- the rudder needed to compensate for an engine
19 out plus, on top of that, you'll be able to make a
20 coordinated turn.

21 MR. CHATRENET: And to damp the dutch roll in
22 case of turbulence, that's right.

23 MR. MAGLADRY: Okay. Thank you. Now I'd
24 like to refer to -- we don't need to display them, but
25 I'd like to refer to Exhibit 9-B, pages four through

1 six. This describes the A-300-B2-B4 rudder travel
2 limiter configuration. This is the -- the B2-B4
3 preceded the A-300-600. Can you please describe the
4 difference in operation of these two rudder control
5 systems?

6 MR. CHATRENET: Yes. If you like, I have
7 some -- some slides to show the difference between the
8 two systems.

9 MR. MAGLADRY: Please.

10 (Slide)

11 MR. CHATRENET: So I have said that maximum
12 rudder deflection was only needed at low speed and that
13 it was appropriate then to limit the maximum rudder
14 deflection at high speed. There are basically two main
15 principle of limitation I am aware of. The first one
16 is known as the variable ratio type of device. With
17 this type of device, the rudder pedal inputs comes
18 here. And then through a variable ratio which is
19 driven by speed, the output of this device is only a
20 ratio of the input. Basically, to have an order of
21 magnitude, this ratio would be one at very low speed
22 and something like one above six at high speed, which
23 means that -- that the ratio is divided by something
24 around six.

25 And then, the output of this variable ratio

1 device will drive the input rod of the rudder servo
2 actuators. This translates into a characteristic
3 between the achieved rudder deflection as a function of
4 the rudder pedal deflection. At low speed for a given
5 rudder pedal deflection, you get the maximum rudder
6 deflection. And as speeds -- as speed builds up, you
7 get a lower deflection from the same rudder pedal
8 deflection.

9 This is a variable ratio type of device.
10 This is the type of device which is fitted on the B2-B4
11 type of aircraft.

12 MR. MAGLADRY: To summarize, I guess, is that
13 -- is it true that you would be able to -- the way that
14 the pilot would be able to distinguish this from the --
15 the A-300-600 system is that at high air speeds the
16 pilot would push -- if he chose to push full on the
17 rudder, the displacement would be the same as he would
18 experience on the ground where he had full authority of
19 the rudder, is that true?

20 MR. CHATRENET: This is true, yes.

21 MR. MAGLADRY: Okay.

22 MR. CHATRENET: Then, the second type of
23 device is called the variable limit, and this device is
24 associated with the fixed ratio type. So in this case
25 there is a constant ratio basically of one, if you

1 like, between the rudder pedal's output and what is
2 driving in fact the input rod of the servo actuators.
3 And the limitation is obtained by the set of stops
4 which I would say with their amplitude is varied
5 according to the speed.

6 So in this case, you have the same ratio
7 between the input and the output of the device but the
8 range of displacement which is allowed by the device is
9 reduced as the speed increases and is translated into
10 the same kind of chart where then you have the rudder
11 pedal deflection and the rudder deflection. And you
12 see that the ratio is always the same, which means that
13 you have always the same gain between your pedal
14 deflection and the rudder deflection but the available
15 range is reduced when the speed is up.

16 MR. MAGLADRY: Okay. And equating that again
17 to what the pilot would feel or how he would understand
18 the difference in the two systems, if the pilot pushed
19 at high air speeds on this type of system, the pedal
20 would be restricted for less travel than at lower air
21 speeds?

22 MR. CHATRENET: This is true.

23 MR. MAGLADRY: Okay. Thank you.

24 MR. CHATRENET: So just -- just to comment
25 about this -- both types, both types are obviously

1 functional. They are certified on various type of
2 aircraft. We have said earlier that the B2-B4 is
3 fitted with a variable ratio type whereas the A-300-
4 600-R is fitted with a variable limit fixed ratio.
5 This device, as has been explained, is also monitored.

6 The variable limit fixed ratio type of device
7 is most commonly used. We have made an approximate
8 computation which show that the 9000 aircraft out of
9 12,000 aircraft in service are flying with variable
10 limit or fixed ratio types or similar type of device
11 where there is a fixed ratio between the rudder pedal
12 and the rudder.

13 And we have -- we have selected for the A-
14 300-600-R the variable limit device because of the
15 advantages of the system. And the system first offers
16 by principle a constant ratio between the rudder pedals
17 and the rudder deflection which is basically consistent
18 with what we have between the control wheel and the
19 ailerons.

20 So as I said, the -- from a handling quality
21 point of view, roll and yaw axis are to be considered
22 together. And it's important to -- to have some kind
23 of consistency between the two axes. This is a way to
24 achieve some consistency between the roll control and
25 yaw control by providing the same type of constant

1 ratio between control wheel and aileron on one side,
2 between rudder pedal and rudder on the other side. It
3 is a less complex system. The variable limit is far
4 simpler. And the failure modes -- and the failure
5 modes of the system are less severe.

6 MR. MAGLADRY: Can you elaborate on the
7 failure modes?

8 MR. CHATRENET: The failure modes -- the --
9 the advantage of the variable limit is that any failure
10 mode will not be an active one. It will not change the
11 -- the rudder deflection without any rudder pedal
12 movement or will not affect the gain between the rudder
13 pedal and the rudder, whereas with the variable ratio
14 we have to take care of this kind of failure that
15 deserves a particular -- particular treatment in order
16 to avoid the consequences of the failure.

17 Remember that normally the safe position of
18 all of these device is to come back to a low speed
19 configuration when you provide the pilot with the
20 maximum authority. If -- with the variable ratio, by
21 doing that, you would multiply the -- the authority of
22 the pilot with a factor of six, which you must do with
23 care before -- to avoid this kind of I would say active
24 consequence of the failure.

25 With the variable limit, the failure mode

1 will just open the limit between no change, any -- of
2 the aircraft at the time of the failure.

3 MR. MAGLADRY: Are -- are you saying that
4 there are failure modes of the ratio type device that
5 actually will move the rudder?

6 MR. CHATRENET: If they are not properly
7 addressed by the -- by the failure analyst, yes, it
8 could move. For instance, if you have a trim position,
9 say a trim position of half a degree in close, for
10 instance, and if your -- if your variable ratio changed
11 to low speed instantaneously, this rudder deflection
12 would change from 0.5 degree to three degree at the
13 time of the failure.

14 MR. MAGLADRY: I see.

15 MR. CHATRENET: I'm not saying that -- that
16 it is -- must be taken into account properly in the
17 design of the -- of the system in order to avoid this
18 kind of failure.

19 MR. MAGLADRY: Now, Mr. Annibale, could you
20 please display Exhibit 9-B, page five?

21 MR. CLARK: Let me ask a quick question, sir.
22 You made a comment earlier about harmony between the
23 pitch and the roll controls. Would you explain what
24 you mean by "harmony"?

25 MR. CHATRENET: I was referring -- referring

1 to harmony between roll control and yaw control,
2 between the --

3 MR. CLARK: Oh.

4 MR. CHATRENET: -- control wheel and the yaw
5 -- and the pedal.

6 MR. CLARK: And what do you mean by
7 "harmony"?

8 MR. CHATRENET: It's basically when you have
9 the same fixed ratio between the control wheel and the
10 ailerons and between the rudder pedal and the rudder.
11 The perceived efficiency of these controls when the
12 speed will build up is consistent, which means that for
13 the same amount of control wheel you will get higher
14 aileron efficiency when the speed builds up. And
15 similarly, for the same rudder deflection, you will
16 have higher efficiency when the speed builds up. So
17 both axes behave similarly.

18 MR. CLARK: Is that a force issue or a
19 position issue? To achieve harmony, is it position or
20 force?

21 MR. CHATRENET: It should be a force issue.
22 From the pilot point of view, it should be a force
23 issue.

24 MR. CLARK: And you may not be the right
25 person to ask, but how much consideration of stability

1 and control goes into the -- the design schedule that
2 you've put in, both from the control loading and from
3 the limiter?

4 MR. CHATRENET: Could you -- could you --

5 MR. CLARK: Sure. The -- what considerations
6 regarding stability and control -- what -- what is
7 evaluated about stability and control in this design?

8 MR. CHATRENET: So basically, the flight
9 control design is first designed with pilots during the
10 design phase. Then it is tested on the ground before
11 the aircraft actually flies. We have simulators to
12 test it. Then it is very comprehensively tested during
13 flight test where we made hundreds of maneuvers which
14 are similar to the maneuvers of the aircraft in service
15 and hundreds of other maneuvers which are far beyond
16 what the aircraft will be expected to see in service.
17 And it's during all this process that the flight
18 control people and pilots are checking that the design
19 is appropriate.

20 To develop this point more in-depth, I think
21 that following witnesses will be more expert than me to
22 -- to discuss this point.

23 MR. CLARK: Fair enough. Thank you.

24 MR. MAGLADRY: Could we display that -- that
25 illustration again?

1 (Slide)

2 MR. MAGLADRY: This illustration is somewhat
3 complicated. But what we've presented here is both
4 Airbus's estimate of what the -- the rudder was doing
5 during the last few seconds of the accident flight,
6 what NTSB's best guess -- best analysis has produced
7 for where the rudder is during that flight. I've also
8 included a simulation of what the yaw damper was doing
9 from models of the yaw damper system.

10 There are two -- two points that I would like
11 you to comment. The red trace is the Airbus simulation
12 of the rudder. And at -- there are two points towards
13 the end there where the trace appears to exceed the
14 rudder travel limiter. The rudder travel limiter is
15 that line that brackets both of the traces and ends up
16 at 7.57 there. Yes, where you're pointing is one -- is
17 the first one, and then the next one is above that.

18 Can you comment on these places where we see
19 the -- it appears that the rudder is exceeding the
20 rudder travel limiter?

21 MR. CHATRENET: Okay. So for the -- for the
22 first -- for the first exceedance, we show that the
23 rudder deflection is basically constant and is
24 consistent with the theoretical travel -- rudder travel
25 limiter at the very beginning of the -- of this short

1 sequence of time. After that it is constant.

2 In order to -- to explain this point, we are
3 ready to -- to anticipate on the following explanation.

4 But Mr. Van den Bossche explained that the TLU is
5 driven by electrical motor. And this TLU has
6 capability to move the variable stop, the cam which
7 builds the variable stop, up to a certain amount of
8 force which could react against the input of the rudder
9 command, which means that if the rudder controls are
10 already applied against the stop and if they are
11 applied against the stop with a given level of force,
12 then the electrical motor can still drive the cam and
13 move the stop as a function of speed up to a certain
14 level of force applied.

15 If the force is applied on the control in
16 excess of this limit, then the electrical motor which
17 drives the TLU which actually stop moving the TLU. And
18 this is what happens during the -- the first event you
19 have shown on the screen.

20 So the -- if you like, the -- the TLU should
21 move according to the speed, should close a bit
22 according to the speed, but because of the forces which
23 are applied on the control, the -- the servo actuator
24 which moves the cam can no longer move the cam because
25 the forces are too high.

1 The last point --

2 MR. MAGLADRY: So you're saying you -- the --
3 the variable stop actuator was stalled by the forces
4 applied by --

5 MR. CHATRENET: Actually, it was stalled by
6 the forces.

7 MR. MAGLADRY: -- by the pedal forces or yaw
8 damper forces?

9 MR. CHATRENET: Yes. The last -- the last
10 point which shows a bigger discrepancy is explained by
11 two facts. Is that a third -- the event we have just
12 mentioned, when the forces has been raised from the
13 control input, then the -- the -- variable stop
14 actuator, the actuator of the TLU started to move again
15 and to follow the speed profile. It started at the
16 maximum deflection rate. But before -- because it was
17 stalled for a certain period of time, it was still
18 behind a bit the theoretical schedule. This is the
19 first explanation.

20 The second explanation is we are exactly in
21 the time of the estimated separation of the fin from
22 the fuselage. So in this period of time just -- we can
23 imagine that even if the TLU was actually holding firm
24 the control input inside of the fuselage, at the time
25 of the separation when the fin bended and went away,

1 the control rod was likely to be under tension -- under
2 tension. And this tension, it's -- it is sufficient to
3 allow or to consider four millimeter of deformation of
4 tension to explain the difference -- the difference we
5 see between the theoretical TLU and the -- the
6 estimated rudder position.

7 MR. VAN den BOSSCHE: May I come back to a
8 detail, Mr. Magladry?

9 MR. MAGLADRY: Certainly. Yes.

10 MR. VAN den BOSSCHE: You said that the
11 actuator -- variable stop actuator could be stalled
12 either by the force from the pedals or the yaw damper.
13 No. The yaw damper with no force on the pedal cannot
14 stall the variable stop. You need a force on the pedal
15 anyway.

16 MR. MAGLADRY: Okay. So the pedal -- you
17 would have to have the pedal against the stop and --
18 and -- to get the pedal stop, it could be the sum of
19 the pedal input and the yaw damper input to get it to
20 the stop. And then you would have to push harder with
21 the pedal to achieve the high force. And do you know
22 what that force at the pedal would be to stall the
23 actuator?

24 MR. VAN den BOSSCHE: The force at the pedal
25 is about 110, 120 pounds.

1 MR. MAGLADRY: So to achieve that
2 characteristic, you're saying that a force would have
3 to be applied of 100 -- approximately 110 to 120 pounds
4 at the pedal. Along those same lines, discussion of
5 force, the dark green plot at the -- at the top where
6 -- where it shows -- where it's exceeding the rudder
7 travel limiter, you move the cursor to the left, yes.
8 And to that peak. This -- this plot is flight data
9 recorder pedal position scaled so that it is what
10 rudder would be achieved if you put in the pedal that
11 was shown on the flight data recorder. It's also
12 summed with the estimate of the yaw damper.

13 So this is an estimate of what rudder was
14 commanded by those two combinations because we've shown
15 that the rudder command is the sum of the pedal and the
16 yaw damper. But yet, it exceeds the rudder travel
17 limiter by approximately five degrees at that position.
18 Can you explain this?

19 MR. CHATRENET: Yes.

20 CHAIRMAN CARMODY: Excuse me. Would you be
21 sure and point to whatever it is you're explaining
22 because it's a little hard to follow sometimes.

23 MR. MAGLADRY: Yes. We have someone moving
24 the cursor to the -- to the exact peak. But it's the
25 dark -- dark green trace --

1 CHAIRMAN CARMODY: Mm-hmm.

2 MR. MAGLADRY: -- in -- in the illustrations.

3 This -- by the way, I'm sorry, this is Exhibit 9-B,
4 page five, if you want to follow along.

5 And so can you explain why we aren't
6 achieving what was commanded there by the pedals and
7 the yaw damper?

8 MR. CHATRENET: Okay. I admit it's -- it's a
9 complex figure, but there is a lot of information in
10 it.

11 In order to get a better understanding, two
12 things might be reminded before. First important thing
13 is that the order coming from the rudder pedals will be
14 added to the order coming from the yaw damper. And the
15 sum of those is limited by the TLU, which means that
16 you have always the relationship, which means when --
17 when the rudder is on the TLU, which is the case on
18 several time sequences, you have always a relationship
19 -- rudder, pedal, rudder plus yaw damper equal TLU when
20 it is on the stop.

21 The second things we have to be remind in
22 order to understand this figure is that the linkage
23 between the rudder pedal, which are in front of the
24 fuselage at the cockpit location, and the place where
25 the rudder pedal input is summed with the yaw damper,

1 which is at the rear of the fuselage, this linkage has,
2 like any mechanical linkage, some kind of elasticity.

3 We could assume, for instance, that the
4 rudder pedals are deflected and bring the rudder to the
5 stop. In order to deflect the rudder pedal to go in
6 this position, you have to apply the forces which are
7 the forces of the artificial feel device. Then, if you
8 apply additional forces and a significant one, you can
9 somehow play with the elasticity of the linkage.

10 Also, the rudder would not move further.
11 Also, the rudder is still on the stop by pressing hard
12 on your pedal. You can get a rudder pedal position as
13 recorded on the -- the FDR because the rudder pedal
14 position recorded is sensed at the cockpit location.
15 You can get a deflection that is higher than the
16 deflection you have at the back of the fuselage when
17 the sum is made with the yaw damper to go to the TLU.

18 And this kind of elasticity, which is a basic
19 behavior of any mechanical linkage, is characterized so
20 you can get a relationship between how many pounds give
21 how many rudder of elasticity. And this has been
22 measured with quite good confidence during the last
23 ground tests that have been made on Flight 701.

24 So we have to be remind of these two aspect.
25 The sum of the yaw damper plus the rudder pedal input

1 is limited to the TLU. And then, there might be some
2 elasticity.

3 So when -- when bearing in mind this, the --
4 the apparent discrepancies that you are showing at
5 least on three occasions can be accounted for by this
6 elasticity, which means that the pedals -- once the
7 rudder was coming on the stop, the pedals have been
8 pushed further by control forces applied on the pedal.

9 MR. MAGLADRY: And have you done -- you spoke
10 about these tests. Can you estimate what force on the
11 pedals would be required to achieve this kind of
12 circumstance where you have -- you're commanding 16 --
13 16 degrees of rudder but the rudder is only positioned
14 at 11 degrees?

15 MR. CHATRENET: Yes.

16 MR. MAGLADRY: And what would that --

17 MR. CHATRENET: We have derived this
18 characteristics from the ground test. And they are in
19 the area of 130, 140 pounds of force, which is, by the
20 way, consistent with what Mr. Van den Bossche said
21 earlier, that beyond 110 pounds of force we expect that
22 the TLU actuator would stall.

23 MR. MAGLADRY: Can this -- can this
24 characteristic be achieved by a yaw damper or a yaw
25 autopilot back driving the system?

1 MR. CHATRENET: No. This gives further
2 evidence that any type of failure coming from either
3 the yaw damper or the autopilot actuator or even the
4 rudder trim would have moved the rudder obviously,
5 might have moved the rudder pedal, but in which case
6 they could not move the rudder pedal further than what
7 is needed to be consistent with the rudder deflection.

8 We cannot imagine how the pedal motion would be bigger
9 than what is happening at the rear of the aircraft
10 because of potential failure of the -- yaw actuator
11 autopilot system, for instance.

12 MR. MAGLADRY: So you've -- you've examined
13 data which tells you that a back drive from -- from the
14 yaw autopilot will not cause the pedals to exceed --

15 MR. CHATRENET: To exceed this --

16 MR. MAGLADRY: -- normal relationship between
17 pedals and rudder? It will -- it will --

18 MR. CHATRENET: Absolutely. You are right.

19 MR. MAGLADRY: Okay. There's one more thing
20 that I'd like to -- to describe on this. And this is
21 -- the light green trace is the yaw damper, our
22 estimate of the yaw damper command from the accident
23 airplane estimated yaw rates. And at time 8:45
24 approximately, where the cursor is, the yaw damper --
25 and as we move to 8:48, the yaw damper is attempting to

1 command from four degrees right rudder to four degrees,
2 approximately, left rudder. But you notice also during
3 that time frame the rudder stays at 11 degrees --
4 approximately 11 degrees right rudder.

5 And as we talked about extensively, the
6 rudder position is the sum of the pedal input and yaw
7 damper input. This illustrates is that -- that pedal
8 input can negate the effect of the yaw damper command.

9 And -- and my question is, are there advantages to
10 designing a system with this characteristic?

11 MR. CHATRENET: First thing is the yaw
12 damper's apparent lack of efficiency. You have said
13 that the -- the -- looks like the yaw damper is no
14 longer active, is only happening if forces are applied
15 on the rudder pedal, which means basically that the
16 rudder pedals are moved by the pilot in a way that is
17 actually compensating what the yaw damper is doing.

18 So it needs the pilot to -- to apply
19 significant forces to apparently cancel the effect of
20 the yaw damper. This results from a design choice or
21 design principle to limit the sum of the pedal order
22 plus the yaw damper by the TLU and to -- to put the
23 rudder travel limiter, the TLU, at the end after adding
24 the yaw damper order rather than before.

25 This is a design principle. It is justified

1 by two facts. The first one is that the TLU always
2 offer sufficient margin to allow for normal operation
3 of the yaw damper. In these circumstances, for
4 instance, the yaw damper will command for between plus
5 or minus four degree of rudder and the TLU is set at
6 around 10 degree, which means that every time the TLU
7 is set in order to allow full activity of the yaw
8 damper.

9 It is even true in the case of one-engine-out
10 condition. Even if we are in a one-engine-out
11 condition, roughly speaking it would need seven degree
12 of rudder and it would still allow for three degree of
13 yaw damper activity.

14 So for any expected operation of the
15 aircraft, the TLU always allows for the yaw damper to
16 be active.

17 Now, if we assume that in some unexpected
18 circumstances the control of the aircraft would require
19 the full rudder deflection, say 10 degree in these
20 circumstances. Ten degree is consistent with what is
21 done for the design load and so on. So if we assume
22 that some unexpected condition would require the rudder
23 to be deflected at 10 degree. We can imagine, for
24 instance, a thrust reversal deployment in flight or a
25 collision with another aircraft.

1 In this case, we prefer to give higher
2 authority to what is coming from the rudder pedal than
3 what is coming from the yaw damper. It would not be
4 appropriate to say that if the aircraft is requiring 10
5 degree of rudder deflection. If the airplane is
6 designed for 10 degree of rudder deflection, we would
7 only allow the aircraft to give seven degree because
8 the yaw damper would be removing three degree. So it's
9 a -- it's a question of design principle.

10 More authority is given to the rudder pedal
11 than to the yaw damper. And the whole system is
12 consistent. The loads are computed accordingly. The
13 failure of the yaw damper are contained accordingly
14 because in this case the failure of the yaw damper
15 anyway are contained by the TLU. So this is irrational
16 for our architecture.

17 MR. MAGLADRY: I have a specific question
18 about the -- the rate -- the response of the variable
19 stop actuator.

20 Mr. Annibale, can you please display Exhibit
21 9-B, page seven?

22 (Slide)

23 MR. MAGLADRY: This illustration is derived
24 from flight data recorder information about the air
25 speed of the accident flight. I've taken this

1 information and taken the derivation of the -- of the
2 air speed to get the rate of change of air speed. And
3 we talked about the variable stop actuator is a jack
4 screw that adjusts the travel limiter.

5 Would the variable stop actuator be able to
6 keep up with the rate of change of air speed that
7 occurred in this flight?

8 MR. VAN den BOSSCHE: The maximum speed --
9 maximum rate of the actuator is one millimeter per
10 second or 0.04 inches per second in this area of the
11 known linear limitation curve, this is 240 knots. This
12 is equivalent to a speed variation of four knots per
13 second. The peak that I can see at the time -- one is
14 of about four knots per second. So the actuator is
15 capable of following such movements.

16 MR. MAGLADRY: And so for all intents and
17 purposes, up till -- excluding that one spike at four
18 knots, it appears to be able to keep up with the rate
19 of change of air speed up until the point of -- of
20 approximately eight -- FDR time 8:50 --

21 MR. VAN den BOSSCHE: Yes.

22 MR. MAGLADRY: -- where it spikes up to 14
23 degrees per second.

24 MR. VAN den BOSSCHE: Yes.

25 MR. MAGLADRY: Is that significant?

1 MR. VAN den BOSSCHE: I don't know where the
2 --

3 CHAIRMAN CARMODY: Excuse me. We can't hear
4 you, Monsieur. Would you speak a little closer to the
5 microphone? Thank you.

6 MR. VAN den BOSSCHE: Well, at this point,
7 the actuator will not be able to follow. And I guess
8 this is close to the vertical stabilizer separation.

9 MR. MAGLADRY: Mr. Chatrenet, do you feel
10 that -- that the rate of change of air speed is
11 significant, that inability to -- the VSA to keep up is
12 significant at that point?

13 MR. CHATRENET: No. For what we have -- for
14 what Mr. Van den Bossche has explained, the four-knot-
15 per-second capability is well capable of keeping up
16 with all the speed variation we see basically up to the
17 estimated time of feel separation. The speed variation
18 is well contained within the -- the -- capability.

19 MR. MAGLADRY: This may be difficult to
20 calculate in your head but I know you're very capable.
21 Can you estimate what the maximum discrepancy would be
22 between the theoretical value and the -- and the -- and
23 the value due to its inability to keep up? In other
24 words, what's the maximum amount of error at this point
25 in terms of allowable rudder?

1 MR. VAN den BOSSCHE: I'm not sure I
2 understand the question.

3 MR. MAGLADRY: At a theoretical value of 268
4 knots, the rudder travel limiter should be at a certain
5 position.

6 MR. VAN den BOSSCHE: Mm-hmm.

7 MR. MAGLADRY: But because the rudder travel
8 limiter cannot keep up, what position would it be in?

9 MR. VAN den BOSSCHE: The rate of the
10 actuator depends on the load which is applied on the
11 variable stop and rate reduces when the load is high.
12 So to -- to fully understand what happens in terms of
13 variable stop position variation, it should be
14 associated to the load on the pedals. I can't tell you
15 more.

16 MR. MAGLADRY: Okay. Thank you. Can you
17 please describe any in-service events that occurred
18 with rudder travel limiting systems that are relevant
19 -- may or may not be relevant to this accident
20 investigation?

21 MR. VAN den BOSSCHE: We have been reported
22 once a variable stop actuator failure which was
23 supposed to be associated with a reported stiff pedal
24 thing. The teardown examination of the actuator has
25 shown a bearing hot point or seizure to a point that

1 the unit was quasi-jammed. And it was quasi-jammed at
2 the position of 26 degrees of rudder deflection. So
3 the actuator failure has been explained. The stiff
4 rudder feeling could not be explained from this figure.

5 MR. MAGLADRY: Did that occur in flight or --

6 MR. VAN den BOSSCHE: It occurred in flight.

7 And of course, there has been an associated warning.

8 MR. MAGLADRY: Is that an oral warning?

9 MR. VAN den BOSSCHE: Yes, it was.

10 MR. MAGLADRY: Mr. Chatrenet, did you get an
11 opportunity to review the CVR transcript?

12 MR. CHATRENET: Yes.

13 MR. MAGLADRY: And it would indicate any oral
14 warnings or failures of these systems. Did you notice
15 any oral warnings prior to the --

16 MR. CHATRENET: No.

17 MR. MAGLADRY: -- fin separation?

18 MR. CHATRENET: No. We did not -- not notice
19 any single chime or oral warning before the estimated
20 time of the fin separation.

21 MR. MAGLADRY: I'd like to move on to the
22 rudder servo installations, and that will be my final
23 area of discussion. Can you please describe the
24 operation characteristics of the rudder servos?

25 MR. VAN den BOSSCHE: We have three rudder

1 servo actuators.

2 MR. MAGLADRY: Could you pause just for a
3 moment?

4 For anyone that would like to follow along in
5 the -- in the exhibits, Exhibit 9-E, pages one through
6 four provide illustrations of the rudder control
7 system.

8 CHAIRMAN CARMODY: Thank you, Mr. Magladry.
9 What were the pages again, please? 9-E?

10 MR. MAGLADRY: 9-E, one through four.

11 CHAIRMAN CARMODY: One through four. Thank
12 you.

13 (Pause)

14 MR. VAN den BOSSCHE: Are you going to
15 display the illustration?

16 MR. MAGLADRY: I don't think it's necessary.
17 I think everyone has the illustration. Unless you --
18 okay. Unless you think it augments your presentation.

19 MR. VAN den BOSSCHE: So there are three
20 servo actuators which were working -- which are working
21 in parallel, three simultaneously active. And they are
22 controlled from the variable stop output by control
23 rods, the input rod of each of the actuator being a
24 spring rod.

25 The maximum surface deflection allowed by

1 this actuator is plus or minus 30 degrees. That
2 corresponds to the stops on the linkage. And there is
3 a slight over-travel beyond 30 degrees to reach the
4 position where the piston bottoms the cylinder.

5 The actuator force is 21,000 pounds for each
6 actuator. And the rate of the rudder when the three
7 actuators are active, which is a normal case, is 60
8 degrees per second.

9 CHAIRMAN CARMODY: Excuse me. Was that six-
10 zero?

11 MR. VAN den BOSSCHE: Six-zero.

12 CHAIRMAN CARMODY: Six-zero, thank you.

13 MR. MAGLADRY: Why do you have -- this is
14 kind of a general question. Why do you have three
15 servos on the -- on the surface?

16 MR. VAN den BOSSCHE: We have three servos to
17 deal with failure cases. The failure cases which are
18 considered as engine out are engine non-contained
19 burst. The effect of such a failure is first you lose
20 an engine and then you lose -- you may lose another
21 hydraulic system. So the airplane is in a asymmetry
22 configuration, one engine, and may have lost hydraulic
23 systems, one associated with the failed engine and the
24 one which has been damaged by the debris from the burst
25 engine.

1 In that case, you need the rudder to
2 compensate the asymmetry. This is why we need three
3 rudders from three independent hydraulic power sources.

4 MR. MAGLADRY: In that case, you would have
5 one rudder, and it -- it would have the capacity to
6 displace the rudder at -- up to its capacity?

7 MR. VAN den BOSSCHE: The full deflection --
8 is -- is possible.

9 MR. MAGLADRY: With three actuators, you have
10 a lot of force capacity. At any point during the
11 flight envelope, can air loads stop the three rudders
12 -- rudder actuators from achieving the commanded
13 position?

14 MR. VAN den BOSSCHE: No. In any normal
15 configuration the air loads are lower than the sum of
16 the three servo actuator forces.

17 MR. MAGLADRY: Do you need this capacity of
18 the actuators? Could they be reduced and the safety of
19 the airplane be the same?

20 MR. VAN den BOSSCHE: The actuators are sized
21 for compensating the engine failure. And there's a
22 condition that I've described before. They cannot be
23 reduced.

24 MR. MAGLADRY: What about the rate of these
25 actuators, 60 degrees per second? I noticed earlier

1 that the yaw damper is limited to 39 degrees and I
2 believe the autopilot is limited to 34 degrees. Why do
3 you have the actuators that can achieve rates of 60
4 degrees?

5 MR. VAN den BOSSCHE: We do not need 60
6 degrees per second, but the actuators incorporate a
7 damping function which is there to prevent the rudder
8 to be blown back to its stops on the ground when the
9 systems are not pressurized. And this damping function
10 generates a resisting force. Because of this resisting
11 force, when the rudder is equated with less than three
12 systems, the maximum rate is reduced. And the
13 requirement has been to keep a 15-degree-per-second
14 rate in the event of double lightweight system failure.
15 And the result of that is 60 when everything's normal.

16 MR. MAGLADRY: This is referring back to
17 Exhibit 13-A, page 79. And this -- this illustration,
18 as we discussed before, shows rudder pedal sweeps and
19 rudder surface position.

20 Can we please have that displayed by Mr.
21 Annibale?

22 (Slide)

23 MR. MAGLADRY: Are these rudder positions and
24 rates consistent with normal operation of the rudder
25 control system?

1 MR. CHATRENET: They are a pretty high rate
2 of deflection. They are -- they are allowed for by the
3 system. The system is capable of providing this 60
4 degree per second rate of displacement, but with my
5 experience and knowledge, I would qualify them as
6 pretty high rate of deflection.

7 MR. MAGLADRY: So these can be achieved by
8 normal operation of the rudder servos but you'd say
9 that -- you'd categorize them as high rates, is that
10 true?

11 (No response)

12 MR. MAGLADRY: There's no need for you to
13 comment on that. What I want you to comment on, is the
14 system capable of producing these rates?

15 MR. CHATRENET: The system, when everything
16 is operating, is capable of providing high rate of
17 deflection, which is generally, from my own quality
18 point of view, felt as a good picture of the system.

19 MR. MAGLADRY: My final question is, can you
20 provide information on in-service events that are
21 relevant -- may or may not be relevant to this accident
22 investigation?

23 MR. VAN den BOSSCHE: The in-service event --
24 you mean on the servo controls or --

25 MR. MAGLADRY: On the servo --

1 MR. VAN den BOSSCHE: On servo controls.

2 MR. MAGLADRY: -- servo controls.

3 MR. VAN den BOSSCHE: The in-service event we
4 have had on servo controls are force fighting issues.
5 It's not exactly relevant but we can go through it if
6 you like.

7 MR. MAGLADRY: Please.

8 (Pause)

9 (Slide)

10 MR. VAN den BOSSCHE: We found one case on
11 the A-300-600 of servo control attachment fitting
12 rupture. The cause of the rupture has been identified
13 as some backlash in the input mechanism of one of the
14 three units, generating a wrong input signal,
15 generating force fighting, and a fatigue rupture of the
16 attachment fitting.

17 To cope with that, a mandatory check of the
18 desynchronization has been defined and is performed
19 every 1300 flying hours. This check was basically
20 defined for large synchronization and is being further
21 refined to be able to detect some small
22 desynchronization movement just due to free play.

23 MR. CLARK: If I may, what -- what motion did
24 the rudder take when that failure occurred?

25 MR. VAN den BOSSCHE: When the failure

1 occurred, the motion is still held by the two valid
2 servo actuators.

3 We have had other failures of the same
4 family, I'd say, which were not servo control failures
5 but spring rod failures resulting either in force
6 fighting or rudder offset.

7 The event was -- was in sometimes the rudder
8 remains partially deflected after takeoff. And the
9 root cause of that has been identified as spring rod
10 jammed, which means with the level of internal friction
11 higher than the -- the spring force and jammed out of
12 neutral.

13 The -- the discrete friction registered from
14 two factors, internal corrosion and swelling of plastic
15 components, of polyamete sliding components.

16 Corrective actions have been defined and have
17 been made mandatory. The first was to increase
18 diameter of the ring hose in the spring rod body and to
19 change the material of the sliding components from
20 polyamete to PTFE. And it was at this occasion that
21 the first desynchronization check has been introduced
22 to be performed every 1300 hours.

23 If we like to identify whether there is
24 similarity with Flight 587, first the spring rods have
25 been examined and it has been discovered that prior to

1 the accident they were serviceable and were working.
2 The spring rod modifications that I mentioned had been
3 incorporated before the accident. And the rupture of
4 the attachment fitting was static and not fatigue, as
5 it would have been in the event of force fighting.

6 And in the event of an offset caused by these
7 control rods, the pilot reaction would have been
8 opposite in all.

9 MR. MAGLADRY: I guess I have one more
10 question. Take -- take an event of remote failure of
11 two servos and these two servos drive the rudder in a
12 particular direction, overpowering one of the other
13 servos. How would that be transmitted back to the
14 pedals and in what proportion?

15 MR. VAN den BOSSCHE: I'm not sure I have
16 understood. Could you rephrase that question? In
17 which circumstance you --

18 MR. MAGLADRY: This is a theoretical
19 circumstance --

20 MR. VAN den BOSSCHE: Yes.

21 MR. MAGLADRY: -- that you did not present
22 here. If -- if there were some failure that caused two
23 of the servos to drive in a particular direction --

24 MR. VAN den BOSSCHE: Yes.

25 MR. MAGLADRY: -- and overpowering the third

1 servo, this -- this motion presumably would be
2 transmitted back through the control linkage and -- and
3 move the pedals. Can you quantify how much rudder
4 motion would be -- would occur before -- before you'd
5 see pedal motions?

6 MR. VAN den BOSSCHE: In that condition, the
7 two valid servos would drive the failed servo through
8 its pressure relief valve. So the two valid servos
9 would be capable of driving the rudder with a reduced
10 hinge movement capability. It means that it would be
11 -- it wouldn't be possible to drive the rudder beyond
12 a certain angle. But in no case there is by driving.

13 MR. MAGLADRY: Do you know how much -- say
14 the rudder -- the rudder was driven to 10 degrees.
15 Would the pedals be driven a proportional amount?

16 MR. VAN den BOSSCHE: I'm saying that the
17 pedals cannot be back driven.

18 MR. MAGLADRY: Are there --

19 MR. VAN den BOSSCHE: I may not understand
20 your question.

21 MR. MAGLADRY: Are there -- there must be --
22 there are stops on the rudder servo actuators.

23 MR. VAN den BOSSCHE: Yes.

24 MR. MAGLADRY: And as the servos displace,
25 the stops would contact the control linkage and move

1 the linkage and -- back to the pedals, is that true?

2 MR. VAN den BOSSCHE: Yes, if there was no
3 hydraulic power at all. When driving the rudder you
4 would be able to back drive the linkage through the
5 input lever stops, that's correct. But in the
6 circumstance you mentioned, which is two valid servos
7 driving one failed servo --

8 MR. MAGLADRY: I'm sorry. Maybe I
9 misrepresented that. It would be two failed servos.
10 So they're not responding to a command from the pedals.
11 They're -- they're runaway, I guess we would call it,
12 or a hardover. And as those servos drive from -- away
13 from the commanded position, they would pick up the
14 linkage and back drive the pedals. And my question
15 was, in what proportion -- if you had that instance of
16 failure and you had 10 degrees of rudder as a result of
17 two servo failures, what would be the result of the
18 pedal displacement?

19 MR. VAN den BOSSCHE: I still have
20 difficulties in understanding your failure conditions.
21 Are you telling me that two servos could runaway, both
22 together, and not the third one?

23 MR. MAGLADRY: That's the failure scenario
24 that I'm --

25 MR. VAN den BOSSCHE: Oh, yes.

1 MR. MAGLADRY: -- theorizing.

2 MR. VAN den BOSSCHE: Yes, it's a very
3 hypothetical case.

4 MR. MAGLADRY: Yes --

5 MR. VAN den BOSSCHE: And in that case, of
6 course, the rudder could be -- the rudder control could
7 be back driven --

8 MR. MAGLADRY: Yes.

9 MR. VAN den BOSSCHE: -- and the pedals would
10 be behind the rudder position to an amount of four
11 degrees, let's say.

12 MR. MAGLADRY: So is --

13 MR. VAN den BOSSCHE: If four degrees is a
14 clear answer to the input lever stops plus stroke of
15 the spring rods.

16 MR. MAGLADRY: So if we were to look at
17 flight data from a -- from a -- this failure scenario,
18 we would see the rudder move first and then the -- then
19 the pedals would follow later --

20 MR. VAN den BOSSCHE: No.

21 MR. MAGLADRY: -- after the -- after the
22 rudder moved four degrees?

23 MR. VAN den BOSSCHE: No. The movement of
24 the pedals is still ahead of the movement of the rudder
25 on the traces we have been shown.

1 MR. MAGLADRY: But in this -- in this
2 scenario, if the -- the rudder would move -- this
3 failure scenario, the rudder would move four degrees
4 and then the pedals would move --

5 MR. VAN den BOSSCHE: Yes.

6 MR. MAGLADRY: -- is that correct? Okay.
7 And then my next question would be, as you already
8 answered, is this what we saw in the accident sequence?

9 MR. VAN den BOSSCHE: No.

10 MR. MAGLADRY: Thank you.

11 Madam Chairman, this ends my line of
12 questioning.

13 CHAIRMAN CARMODY: Thank you, Mr. Magladry.
14 I know that Mr. O'Callaghan has a number of questions
15 of these witnesses and there may be others. But I
16 would suggest that we break for lunch for one hour.

17 Mr. Clark, did you want to say something?

18 MR. CLARK: If I may --

19 CHAIRMAN CARMODY: Sure.

20 MR. CLARK: -- I've got a -- just a --

21 CHAIRMAN CARMODY: Fine. Why don't you --

22 MR. CLARK: -- quick follow-up and then I'll
23 try to get out of there.

24 CHAIRMAN CARMODY: -- follow up?

25 MR. CLARK: Okay. On the -- on the types of

1 failure modes, are there failure modes in which the
2 rudder can move farther than the limiter would allow?

3 MR. VAN den BOSSCHE: No, I don't think so.

4 MR. CLARK: Are there failure modes that
5 you've identified that would --

6 MR. VAN den BOSSCHE: Oh. Well, it could
7 move on a limited quantity due to some elasticity
8 effects.

9 MR. CLARK: Okay. And then, for example, the
10 two minus one failure where two actuators have failed
11 and are driving the third, would that allow the rudder
12 to move beyond the limiter --

13 MR. VAN den BOSSCHE: In that --

14 MR. CLARK: -- control?

15 MR. VAN den BOSSCHE: -- in that case, yes.

16 MR. CLARK: Okay. And we would have to go to
17 the blowdown limits of the two minus one --

18 MR. VAN den BOSSCHE: Yes.

19 MR. CLARK: -- to see how far it may move
20 that?

21 MR. VAN den BOSSCHE: Yes.

22 MR. CLARK: Are there any failure modes that
23 you've identified that would promote a cyclic type of
24 motion out of the rudders?

25 MR. VAN den BOSSCHE: No. It's runaway.

1 MR. CLARK: Any kind of failure mode?

2 MR. VAN den BOSSCHE: Yes.

3 MR. CLARK: None?

4 MR. VAN den BOSSCHE: No.

5 MR. CLARK: Okay.

6 MR. VAN den BOSSCHE: Just runaway.

7 MR. CLARK: Okay. Thank you.

8 CHAIRMAN CARMODY: All right. Thank you.

9 I suggest we adjourn for an hour and return
10 at 2:30. Thank you.

11 (Whereupon, at 1:25 p.m., on October 29,
12 2002, the proceedings were adjourned for lunch, to
13 reconvene at 2:30 p.m., the same day.)

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1 A F T E R N O O N S E S S I O N

2 2:34 p.m.

3 Whereupon,

4 DOMINIQUE CHATRENET

5 having previously been duly sworn, was recalled as a
6 witness herein and was examined and testified as
7 follows:

8 Whereupon,

9 DOMINIQUE VAN den BOSSCHE

10 having previously been duly sworn, was recalled as a
11 witness herein and was examined and testified as
12 follows:

13 CHAIRMAN CARMODY: People have been asking
14 how long the hearing is like to run till tonight. I
15 intend certainly to go until seven, possibly later if
16 we're in the middle of something. But we have a lot to
17 cover and the pace has not been crisp up until now. So
18 I intend to be here till seven.

19 The rest of the week we'll start at eight in
20 the morning and again probably go fairly late at night.
21 So we have many witnesses, many subjects, and I don't
22 want to waste time.

23 Everyone, please come in or close the door if
24 you're not coming in because we want to get going here.

25 Thank you.

1 We are going to start with Mr. O'Callaghan's
2 questions of these two witnesses. Please proceed.

3 MR. O'CALLAGHAN: Thank you, Madam Chairman.

4 Good afternoon, gentlemen. My questioning
5 has to deal with the simulator work and calculation of
6 side slip and those sort of things. And I understand
7 that you've prepared a presentation that introduces
8 that matter. So if you're --

9 MR. CHATRENET: Yes.

10 MR. O'CALLAGHAN: -- ready to proceed, please
11 do so. Thank you.

12 MR. CHATRENET: Thank you.

13 (Slide)

14 MR. CHATRENET: So I would like to start to
15 introduce the work we have been doing with the
16 simulation by some basic quality consideration about
17 the role of fin and rudder.

18 So the fin is basically designed to provide
19 -- lateral direction or stability on our aircraft.
20 And it is thanks to the fin that the aircraft has a
21 tendency to remain in or to return to a straight no-
22 side-slip flight.

23 On the left picture you see an aircraft
24 flying straight basically with the velocity of the
25 aircraft contained within the plane of symmetry of the

1 aircraft. In these conditions, the pressure on both
2 sides of the fin are equal and no lateral force applies
3 to the fin.

4 On the right picture we see -- we see an
5 aircraft flying some kind of sideways, which means that
6 the aircraft velocity is no longer in the plane of
7 symmetry of the aircraft. And the angle between the
8 plane of symmetry and the velocity is called the side
9 slip.

10 In this condition, the pressure on both sides
11 of the fin are not equal and the lateral force is
12 developed from the fin which in turn will cause a
13 yawing movement on the aircraft. And the ensuing
14 movement will have a self-natural tendency to bring
15 back the aircraft velocity within the plane of symmetry
16 of the aircraft, which means basically that the
17 aircraft has a self tendency to align itself with the
18 -- with the air like a weather vane would do or -- or
19 to come back basically to -- to side slip naturally to
20 zero side slip.

21 (Slide)

22 MR. CHATRENET: Now, what is the role -- what
23 is the role of the -- of the rudder. One of the
24 fundamental role of the rudder is to provide the
25 lateral forces and associated wing movement to

1 compensate or to oppose the effect of an engine failure
2 or any other yawing asymmetry.

3 On this sketch we see an engine providing
4 full stress on left side while the right engine is
5 assumed to be failed. In this case, the thrust
6 asymmetry -- thrust on one side and no thrust on the
7 other side -- will have a tendency to make the aircraft
8 yaw around its center of gravity.

9 Therefore, the rudder may be used to provide
10 by its deflection lateral forces which multiplied by
11 its lever arm will cause a yawing movement resulting
12 from this rudder deflection which will be able to
13 compensate for the wing movement associated with the
14 engine failure.

15 The second main role of the rudder is to
16 allow for cross wind landing. When the aircraft is
17 coming to land and when there is a significant wind
18 acting across the runway, the trajectory of the
19 aircraft must still remain in the axis of the runway.
20 And if the aircraft heading would be the same as the
21 runway ending, the aircraft could not maintain a
22 trajectory in the ending. The aircraft would drift
23 away from the runway axis. This is why the aircraft is
24 compensating this kind of natural drift by putting some
25 heading change relative to the runway and flying with

1 some kind of a crab angle in order to allow the
2 aircraft trajectory to keep in line with the runway.

3 But this kind of aircraft situation cannot be
4 tolerated at the time of the touchdown. At the time of
5 the touchdown, the landing gear of the aircraft is not
6 designed to support this kind of significant angle
7 relative to the runway, and the aircraft must be
8 brought back in line with the runway. And at this
9 stage -- at this stage, because the wind is coming from
10 one side, the aircraft must fly with side slip.

11 And as the aircraft has a self-tendency to
12 align the nose into the wind in order to create this
13 side slip, the rudder must be deflected in order to
14 compensate for the natural lateral direction -- of the
15 aircraft.

16 So the second case when we must use the
17 rudder is to provide for this kind of landing with
18 cross wind.

19 Now, we will try to illustrate some effects
20 of the rudder use. I have said that the aircraft has a
21 self-tendency to come back to a zero side slip
22 condition and therefore rudder application is not
23 necessary to bring back the aircraft to this zero side
24 slip condition. This return is natural. It is damped
25 but it is also oscillating like it is shown on this

1 figure. The aircraft has a self-tendency to come back
2 to this stage but after several damped oscillations.
3 This kind of oscillation is also commonly called dutch
4 roll.

5 We have been this morning addressing several
6 issue about the yaw damper. The yaw damper function is
7 illustrated here as its contribution to the angling
8 quality of the aircraft. With small rudder deflection
9 automatically applied by the yaw damper system, you can
10 change the behavior of the aircraft from the blue
11 dotted curve to the green solid curve, which is far
12 more damped than the original one, which means that the
13 yaw damper provide this kind of improvement in damping
14 and therefore improvement of comfort.

15 And this is an automatic function that do not
16 -- that does not require any action from the pilot.

17 Now, on the other side, if we assume that
18 some cyclic inputs are made to the rudder at a specific
19 time intervals which is coincident with the natural
20 frequency of the aircraft, even with small inputs at
21 the beginning we can achieve some kind of oscillation
22 of growing amplitude, then at the end stabilizing. But
23 the amplitude is far greater than the amplitude of the
24 initial oscillation.

25 (Slide)

1 MR. CHATRENET: This is the illustration of
2 the forced oscillation principle. If you put some
3 impulses at the frequency of the natural oscillation of
4 the aircraft, you can get higher oscillation than
5 simply damped oscillation.

6 Let me try to -- to use a comparison. It
7 might be like a child's swing. If you take a child's
8 swing and if you offset it from the equilibrium
9 position and just release it, then the swing will come
10 back to the vertical equilibrium state after several
11 damped oscillation.

12 Now, if you take the same swing, you offset
13 it by the same amount, you release it, but each time
14 the swing comes close to you, you just push a little,
15 small impulse but at the right frequency, and then you
16 can obtain a motion of your swing which will be higher
17 than the initial offset. You can this way illustrate
18 the forced oscillation principle. And this is relevant
19 to some kind of inequalities analysis of Flight 587.

20 Another effect of the rudder use that should
21 be emphasized is that if the rudder is capable of
22 creating stabilizing side slip on the aircraft, this
23 will also roll any aircraft because of the side roll
24 effect. And this not peculiar to our -- to our
25 aircraft, this is peculiar to almost all aircraft of

1 the same kind of architecture.

2 So let's illustrate this.

3 (Slide)

4 MR. CHATRENET: Let's do it again.

5 (Slide)

6 MR. CHATRENET: So you see first rudder side
7 slip and roll. So the -- it's true that we can induce
8 roll by the use of rudder.

9 So use of rudder for roll control induces
10 large, indirect, and delayed roll response. And the
11 fact that it needs first the side slip to establish
12 before the roll resulting from the side slip can roll
13 the aircraft, introduces a significant delay in the
14 reaction of the aircraft in roll to a given rudder
15 input. And because of the delay we must be careful
16 because this kind of high efficiency compound with the
17 delay could lead to overcontrol.

18 On our aircraft now we have a pretty powerful
19 roll control through the ailerons and spoiler only, the
20 roll control of the A-300-600-R is pretty efficient.
21 To have an order of magnitude at the speed of 240, 250
22 knots, it can generate a roll rate as high as 30 degree
23 per second. And therefore, the use of rudder for
24 boosting roll control is neither necessary nor appropriate.

25 (Slide)

1 MR. CHATRENET: So after this I would say
2 overall and general introduction of handling qualities
3 matter, let's explain how we have analyzed the accident
4 parameters we had.

5 What were the objectives of all this analyses
6 which have been performed since -- since the accident
7 date and which have been devoted a lot of energy on the
8 Airbus side.

9 The first objective was to compare the
10 aircraft motion as it is recorded on the DFDR with a
11 computed motion of the A-300-600-R simulation model.
12 So comparing what is on the DFDR with what can be
13 obtained with a simulation model of the aircraft.

14 The second objective of this simulation
15 analysis was to derive wind profile during the event,
16 if any.

17 The third objective has been to reconstruct a
18 continuous time history of all control surfaces between
19 the sample recorded data or based on the sample
20 recorded data. In order to have a good analysis of the
21 phenomena, we must rely on some continuous curves
22 whereas the sample data on the DFDR are only recorded
23 at their sampling period, which is some -- most of the
24 control surfaces at two PPS.

25 And the last objective was also to compute

1 thanks to the simulation model the parameters which are
2 not recorded on the DFDR which we are -- which are
3 nevertheless necessary to be an input for the load
4 analysis and to understand the load analysis. Citing
5 namely the side slip. The side slip is not recorded on
6 the aircraft. There is no side slip vane on the large
7 transport aircraft. So we have to deduce from one way
8 or another the side slip. And the rotation rates as
9 well are not directly recorded on the DFDR.

10 So these were the objectives of our analysis.

11 We have used two different methods and we have cross
12 checked the results of the two methods against each
13 other at least for the main parameter for -- which is
14 very relevant for the load analysis, which is the side
15 slip time history.

16 So for the side slip time history, we have
17 used the handling quality model analysis in order to
18 derive a side slip history from this simulation. And
19 we have used another method which is completely
20 independent of the model which is a side slip
21 computation by -- based on integration of the lateral
22 acceleration, which is basically a kinetic mathematical
23 method.

24 So how do we perform our simulation analysis.

25 How do we run our simulation model. We start with an

1 -- the time history for the control surface time
2 history, which is continuous. To give you an idea of
3 what is continuous in our mind, we run our simulation
4 model at 64 points per second. And we assume that at
5 64 points per second we have a good -- a good
6 continuous curve for all parameters which are relevant.

7 So we feed this continuous control surfaces
8 time history into a model of the A-300-600-R. And this
9 model is our model, the model we have since the
10 certification of the aircraft. We have not been
11 changing this model since. It's the model that -- on
12 which we have been relying to certify the aircraft. We
13 have made some simulation. We have used the iron bird.

14 So this -- this simulation model was run at this time,
15 was accepted by the -- authority. And by the way, this
16 simulation model is also the same one which is provided
17 for the training simulator.

18 So this model is an old one. We have not
19 changed it since, and we have used basically the model
20 that is available since the certification date of this
21 aircraft.

22 The result of the simulation when you put as
23 an input the control surface position is to give some
24 parameters for the aircraft motion. So we can compute,
25 for instance, all the acceleration, the NY

1 acceleration, the load -- the vertical load factor. We
2 can compute the speed, the rate, and we can compute
3 also the attitudes, like the pitch angle, the bank
4 angle, the heading, and so forth.

5 In the same time, in the same process,
6 starting with what we believe are the true continuous
7 control surfaces in time history, we reproduce or we
8 introduce in our model the treatment which is made by
9 the DFDR or mainly by the stack computer, which means
10 the -- the filtering of some of the parameters. Some
11 of the parameters are filtered. So this should be
12 taken into account before comparing anything to the
13 DFDR. And this is done -- this is done mainly for the
14 rudder deflection, aileron deflection, and elevator
15 deflection.

16 So by using this process, we obtain control
17 surfaces time history as if recorded -- exactly as if
18 recorded on the DFDR. And then we compare both results
19 with what we have on the DFDR, what are the actual
20 recorded parameters. So we compare both the aircraft
21 motion with the DFDR parameter and we compare the as --
22 as-if recorded control surfaces position with the DFDR.

23 And whenever we are not happy with the
24 comparison, we make an iteration and we change the
25 continuous control surface time history until we are

1 sufficiently happy with both comparison, comparison
2 with the aircraft motion, comparison with the recorded
3 rudder position, aileron position, elevator position.
4 And we have made hundreds of iterations until we are
5 pretty satisfied with the results.

6 (Slide)

7 MR. CHATRENET: This is an illustration of
8 what we can get from this analysis. In red we have the
9 lateral load factor computed by the model whereas in
10 blue we have the recorded points from the DFDR with
11 their sampling. And we show that basically we have a
12 good match of the lateral acceleration of the -- of the
13 last seconds of the flight.

14 The assumed time of fin separation is around
15 here, so we have basically a good representation of the
16 last 12 seconds of the flight before the separation.
17 We have put in dotted line here the result of our model
18 because obviously our model, the certified model,
19 cannot account for the fin separation.

20 (Slide)

21 MR. CHATRENET: Same illustration. Here is
22 the heading angle, heading angle resulting from the
23 model, from the simulation, compared with the points
24 recorded on the DFDR.

25 It is important to note that our simulation

1 has been run during these 12 seconds up to now while
2 assuming no lateral gust, no -- any lateral vortex for
3 this simulation. So up to now, these results can be
4 obtained without any assumption for wind.

5 (Slide)

6 MR. CHATRENET: And this is the result of the
7 second comparison. Here we have the rudder as it is
8 used in our simulation. So this is the rudder position
9 which drives the simulation. This is the rudder
10 filtered, which means it is the parameter as if
11 recorded on the DFDR. So you see here the effect of
12 the filtering of the processing before being put on the
13 DFDR. And then we compare with blue dots which are the
14 DFDR truly recorded points. And you see that we have a
15 pretty, pretty good match of all these points.

16 The second method is called the kinetics
17 integration of the DFDR parameter. This method is
18 completely independent of any aircraft model, and it
19 provides basically the result of the integration of the
20 acceleration relative to -- relative to the Earth,
21 which means relative to the ground. It provides
22 basically ground side slip. Ground side slip would be
23 equal to air side slip in case of no wind.

24 (Slide)

25 MR. CHATRENET: This shows basically the

1 process. We start from the acceleration as they are
2 derived from the DFDR. Then we have to make some
3 angular corrections in order to provide the direct
4 derivative of the main parameters in the correct
5 access. For the angular correction, we use the DFDR
6 altitude where to correct by bank, pitch, angle, and so
7 on. And then by a mathematical integration, which is
8 basically a trapezoidal type of integration, we can get
9 the side slip as computed by this method, called the NY
10 integration.

11 And then we can cross check the side slip,
12 which once again is a ground side slip, once again
13 which does not rely on the model. We can compare with
14 the side slip computed by the aircraft simulation.

15 (Slide)

16 MR. CHATRENET: So the overall result is the
17 following one. We are still talking about the same 12
18 seconds before the estimated time of fin separation.
19 And we can compare in red the side slip coming from the
20 simulation, coming from the model, resulting from the
21 control surface position with the side slip coming from
22 the integration method. We see that we have a pretty,
23 pretty good agreement of both methods at the end of
24 this time period.

25 We have still to work in this area, but

1 remember that blue is ground side slip, red is air side
2 slip. The difference in between might be accounted by
3 some lateral wind, for instance, which was not the case
4 up to now in our simulation because we had pretty good
5 results up to now without taking into account any
6 lateral wind.

7 If there was some wind, this may account for
8 the small difference here. Basically, it's only one
9 degree of side slip. One degree of side slip at this
10 speed, 250 knots, means roughly speaking five knots.
11 Five knots of lateral wind, not more.

12 So as a summary of this analysis, we have
13 been able, thanks to the -- to the use of the model, we
14 have been able to propose a continuous rudder
15 deflection time history. And we think that this
16 continuous rudder time history has been established
17 with a very, very high degree of confidence.

18 The side slip time history, which is very
19 relevant for the load analysis which is necessary for
20 the load analysis that will be described by following
21 witnesses, has been also determined. And for this
22 purpose, we have used two methods. We have cross
23 checked the methods, and we have obtained consistent
24 results with the two methods.

25 (Slide)

1 MR. CHATRENET: The comparison between the
2 DFDR recorded parameters and the aircraft motion
3 derived from the simulation are in good agreement,
4 which means that basically the aircraft model and the
5 aircraft from the Flight 587 behave in a similar way.

6 And all the lateral motions of Flight 587 can
7 be accounted for -- I would say almost entirely because
8 at this stage we have not used any lateral wind
9 assumption -- almost entirely by the roll and yaw
10 surface deflection. The good match we have up to now
11 is obtained without any lateral wind assumptions.

12 I think the system analysis has been covered
13 this morning.

14 MR. O'CALLAGHAN: Thank you, Mr. Chatrenet,
15 for that very comprehensive presentation. Many of the
16 questions I have have been covered in your -- in your
17 presentation, but I'd like to go over just a few things
18 just for emphasis and for clarification.

19 So back on your summary slide, the one you
20 just showed, I guess -- can you repeat again just what
21 were the major factors that affected the motion of the
22 airplane?

23 (Slide)

24 MR. CHATRENET: This -- this one?

25 MR. O'CALLAGHAN: Yeah. For example, like

1 your last bullet there. Basically, just under --
2 understand the simulation match then is -- is good with
3 -- so good with the motions that you've driven with --
4 with the control surface positions you've driven with
5 that that accounts, in your opinion, for almost
6 entirely all the -- all the side slip angle and the
7 other motions we saw, is that -- is that right?

8 MR. CHATRENET: Yes. At least at the end.
9 The only area where we could still improve the matching
10 is the area where we have seen the side slip ground and
11 the side slip air differ slightly which is at the very,
12 very beginning of the -- of the sequence. And as I
13 have said, we do not expect to see a big amount of
14 lateral wind, something around five knots, which is
15 very small, which means that at the end the lateral
16 motions of the aircraft will still remain resulting
17 from at least 95 percent as a result of the control
18 surface position.

19 MR. O'CALLAGHAN: Okay. Thank you. So these
20 -- these results, can they also be used to examine the
21 question of whether any other parts separated from the
22 airplane prior to when we think the vertical fin came
23 off? For example, the rudder?

24 MR. CHATRENET: This -- this might be -- used
25 from the fact that up to the estimated time of the fin

1 separation basically the model and the Flight 587
2 behaved in a similar way, which means that the aircraft
3 is complete up to this time. After, we have seen that
4 basically there is a sharp pop in the lateral load
5 factor that the model cannot account for and which
6 might be the evidence that at this time the aircraft is
7 no longer behaving like the model because the aircraft
8 is no longer complete.

9 MR. O'CALLAGHAN: Thank you. Along those
10 same lines, if I can refer you to page -- looks like
11 page 95 of Exhibit 13-A.

12 Could we have that one up there, please?

13 (Slide)

14 MR. O'CALLAGHAN: Now, the -- the lower chart
15 shows the time history of the side slip angle from one
16 of your simulations and an inertial side slip angle
17 calculated by the NTSB in much the same way as your --
18 as your derivation of side slip angle from the lateral
19 accelerations. And we see there at -- at about 9:15:58
20 and a half or so, the -- the simulator side slip angle
21 and the integration side slip angle start to diverge.
22 Can you just comment on the reason for that?

23 MR. CHATRENET: So if -- if the -- if you are
24 referring to the divergence we see at the -- at the end
25 of this time history, I -- I've explained that the

1 model cannot account for the separation of the fin. So
2 the -- the big divergence we can see between the side
3 slip at the end to my interpretation is linked with the
4 separation of the fin, which means that basically the
5 -- the aircraft cannot behave like the model which
6 has a fin on it.

7 Before that we -- on this exhibit the side
8 slip comparison is not exactly the one that I have
9 shown earlier. And we have made this progressive
10 analysis with the side slip. We have been discussing
11 our results with NTSB. And in the last stages we have
12 completely included the various corrections which are
13 necessary on the accelerometers. And we have included
14 the correct synchronization of the parameters that were
15 not done before. And this is to my interpretation the
16 explanation of this last iteration which may account
17 for the difference we have seen between the curves as
18 shown in this one.

19 MR. O'CALLAGHAN: Okay. Thank you. And just
20 to summarize then, the divergence at time 9:15:58 and a
21 half or so is again another indication along with other
22 evidence that has been presented that the fin came off
23 at that time?

24 MR. CHATRENET: Exactly, yes.

25 MR. O'CALLAGHAN: Okay. Just a couple

1 questions about the fidelity of the simulator and how
2 it -- how accurate it is in representing the real
3 airplane. Are there regimes of flight or combinations
4 of angle attack or side slip beyond which the simulator
5 model does not represent the -- the airplane too
6 accurately? And how do those ranges compare with the
7 -- the ranges of angles of attack and side slip that
8 have been analyzed for this accident?

9 MR. CHATRENET: Yes, there are obviously
10 areas where the model is not completely at least
11 substantiated by -- by testing. Basically, the model
12 we use is initially based on wind tunnel test results.
13 These wind tunnel test results have their own range of
14 validity of parameter. By continuity, generally this
15 model is expanded beyond the validity of the parameter
16 for continuity reasons. And for instance, when some
17 parameters are linear, their domain of validity is
18 basically unlimited or so it is outside of what has
19 been tested in -- in wind tunnel.

20 When the aircraft is flying, we are
21 performing a lot of flight testing dedicated -- purely
22 dedicated to identify our model and to tune the model
23 until we get a good matching with the flight test
24 results. So basically, we have validity -- we have a
25 range of parameters which have been tested in flight

1 and which have allowed to derive some adjustment
2 coefficient that will be used across the whole range.

3 Beyond this range of parameters validated by
4 flight tests, we have the range of parameter -- we have
5 the range of parameters validated by wind tunnel tests.

6 And beyond, we have the range which is expanded by
7 extrapolation or by linear -- the linearization model.

8 In the parameters that we encountered during
9 the few -- the few last seconds before the fin
10 separation, the angle of attack and the side slip
11 within the range of parameters which have been
12 supported by flight tests.

13 MR. O'CALLAGHAN: Okay. I think that that's
14 key, that basically for -- for where the -- for where
15 the simulation is taking place, the ranges of angle
16 attack and side slip are -- have actually been
17 validated by flight tests, not just wind tunnel data?

18 MR. CHATRENET: Yes.

19 MR. O'CALLAGHAN: Okay.

20 MR. CHATRENET: Yes.

21 MR. O'CALLAGHAN: Thank you. Mr. Chatrenet,
22 you mentioned that some external winds were required in
23 the longitudinal axis to help match angle attack and
24 load factors. And you mentioned also the possibility
25 of introducing lateral winds on the order of five knots

1 or so to help improve the match of side slip angle.
2 Any speculation on what the source of these external
3 winds might be?

4 MR. CHATRENET: These might be turbulence or
5 wake -- or wake-associated turbulence.

6 MR. O'CALLAGHAN: Okay. Thank you.

7 MR. CHATRENET: The -- the magnitude of them
8 are about five to seven knots in vertical wind up to
9 now. So once again they are small. They are small.
10 Five -- five to seven knots is a small to moderate
11 turbulence.

12 MR. O'CALLAGHAN: Yes. And in any case,
13 their overall effect on the -- on the motion of the
14 airplane compared to that of the flight control inputs
15 is -- you mentioned a ratio before.

16 MR. CHATRENET: Laterally it will remain
17 small, yes.

18 MR. O'CALLAGHAN: Okay. Just a couple
19 questions on -- on the yaw damper. Mr. Magladry
20 questioned you extensively on that earlier in the day.
21 I just want to explore how the yaw damper affects the
22 motion of the airplane.

23 And if I can reiterate a little bit of my
24 understanding of what the testimony this morning was
25 and to see if I've got it right, but essentially

1 question you why -- why the rudder traces are the way
2 they are and the way they were driven in the
3 simulation. The way I understand it is the pilot can
4 input or -- pedal input and move the rudder to the
5 limit and the yaw damper may be attempting to move the
6 rudder back towards neutral. But in doing so, it makes
7 more pedal travel available to the pilot. So then, if
8 there's force continued to be pushed on the pedal, then
9 -- then the effect of the yaw damper is negated or
10 compensated for and the rudder will move back to the --
11 back to the rudder stop. Is -- have I stated that
12 correctly so far?

13 MR. CHATRENET: That is correct, yes.

14 MR. O'CALLAGHAN: So now, if -- if the -- let
15 me ask it this way, I guess. How would -- how would
16 the use of a pedal limiter in combination with the
17 rudder limiter change or alter the rudder positions
18 obtained from the recorded pedal inputs?

19 MR. CHATRENET: Please, could you say it
20 again?

21 MR. O'CALLAGHAN: Okay. How -- if -- if --
22 if in addition to the rudder limit there was also a
23 pedal limiter so the pilot could only move the pedal a
24 certain distance regardless of what the yaw damper was
25 doing, some -- for example, in the first instance, if

1 he moves the -- if he steps on the pedal and the rudder
2 moves to the limit, then even though the yaw damper
3 were to take away input or move the rudder back towards
4 neutral, if there were a pedal limit the pilot could no
5 -- could not move the pedal any further, then how would
6 -- if -- that implementation of a pedal limiter I'll
7 call it. If that were in the system somewhere, how
8 would that alter the rudder trace that would -- that
9 would result from the pedal inputs?

10 MR. CHATRENET: So actually, I have no -- no
11 simulation, no -- no simulation to substantiate any
12 good answer to your question because the -- the design
13 is not like that. So it's speculative and I cannot
14 support what might be the answer of the aircraft in
15 this -- motion.

16 Let me say that in any case the yaw damper
17 will not be capable of adding anything to the pedal
18 input, which means that because we have the --
19 downstream. So the -- the yaw damper activity, which
20 would be in addition to the pilot authority, would have
21 no effect anyway.

22 The only effect, according to your
23 assumption, would be to allow the yaw damper to remove
24 some authority from the pilot when the yaw damper would
25 be acting against the pilot. And basically, the

1 assumption you are referring to some kind of additional
2 limiter at the level of the pedal is somehow related to
3 the discussion we had this morning about putting the
4 TLU at the most downstream position or putting it
5 upstream after the pedal position.

6 And once again, it's -- it's an architecture
7 choice, a choice for our system design. Because the
8 TLU is sufficiently wide to authorize the yaw damper to
9 act completely with full necessary travel even in case
10 of engine failure, if we think that we have a condition
11 where more rudder deflection would be needed, which
12 means basically the TLU deflection would be needed. We
13 prefer to prevent the yaw damper to remove any pilot
14 authority in this condition. And this is done at the
15 expense of half of the oscillation or the -- yes, the
16 oscillation that the yaw damper may ask for.

17 MR. O'CALLAGHAN: Okay. And I think I did
18 hear you mention that the pedal limiter would allow the
19 yaw damper to remove rudder motion -- can't -- it
20 wouldn't be able to move it beyond the TLU limit, but
21 it would be able to move it back more towards neutral?

22 MR. CHATRENET: Yes.

23 MR. O'CALLAGHAN: Is that --

24 MR. CHATRENET: Yes. But never to neutral.
25 You remember that the -- the yaw damper authority is

1 always less than the pilot authority. It's basically
2 one-third of the pilot authority.

3 Remember also that when we are talking about
4 cyclic inputs on the rudder which frequency is in the
5 range of the natural aircraft oscillation frequency,
6 only small rudder inputs are necessary to get a forced
7 oscillation with high amplitude.

8 So also I have no simulation to -- to -- to
9 support your assumption, but we can imagine that the
10 pilot authority would still remain big enough to cause
11 this kind of force oscillation.

12 MR. O'CALLAGHAN: And again, recognizing
13 fully that without a simulation these are all
14 speculative, but we can, like you say, use our
15 imaginations a bit. And so with -- with a square pedal
16 input but with a yaw damper that could say attenuate
17 the -- the resulting rudder, what kind of effect would
18 the attenuated rudder have on the side slip angles that
19 would develop compared to say to -- if -- if the rudder
20 were fully square?

21 MR. CHATRENET: I cannot support any answer
22 because we have not made any simulation like that. So
23 we could not tell you which kind of either attenuation
24 or -- I don't know. I could not answer precisely
25 because we have not made any simulation to support this

1 kind of assumption, which is not the way the aircraft
2 is designed. So we have made many, many simulations
3 but based on the actual design of our aircraft.

4 MR. O'CALLAGHAN: Okay. Thank you. Speaking
5 -- I guess -- moving a bit to different design, can
6 square inputs such as those were -- were -- that were
7 determined to have occurred on -- on the accident
8 airplane, can -- can those be obtained by -- with
9 square pedal inputs on the fly-by-wire fleet of Airbus
10 airplanes?

11 MR. CHATRENET: I'm afraid that any
12 comparison with the fly-by-wire aircraft is difficult
13 to make at this stage. These aircraft are too much
14 different in terms of design. And it's mainly because
15 of the flight control loads that we have implemented in
16 the fly-by-wire aircraft.

17 Remember, for instance, also it is not
18 relevant to the Flight 587. But nevertheless, it is
19 worth to -- at least to mention it. The fly-by-wire
20 craft, they have control loads which, for instance,
21 allows the rudder to move as a consequence of the side
22 stick motion involved. So even with no input from the
23 pedals, the rudder would move when you move the side
24 stick.

25 Similarly, with no side stick input but with

1 the rudder pedal motion, the aileron and spoiler will
2 move as well as a result of the flight control load,
3 which means that the basic handling quality would be
4 heavier. Our fly-by-wire aircraft is completely
5 different and not comparable at all with the handling
6 quality of the A-300-600-R, which makes any comparison
7 very difficult or even irrelevant.

8 MR. O'CALLAGHAN: Okay. Then, my final
9 question would just be on -- on a fly-by-wire aircraft
10 -- I think it's somewhat relevant in how you're looking
11 at how different designs work and as -- as airplanes
12 are designed in the future how different technology can
13 -- can be brought to bear. So my final question would
14 then just be on a fly-by-wire aircraft, what kind of
15 rudder or side slip generally would result from square
16 rudder inputs? Even in the absence of a simulation,
17 without -- as -- how is that different from say older
18 technology aircraft?

19 MR. CHATRENET: So a main first difference is
20 that in the roll and yaw axis the fly-by-wire aircraft
21 have a bank angle protection system, which means that
22 the aircraft is not likely to go to excessive bank angle.

23 So as a consequence of that, the -- the
24 likelihood of any upset in lateral is far, far remote,
25 not to say almost inexistent of the fly-by-wire. So

1 this is one first difference which say that the
2 aircraft is unlikely to be upset in lateral.

3 The second difference is that with the fly-
4 by-wire, when you are deflecting the rudder pedal, you
5 are asking for a side slip. So there is a relationship
6 between the rudder pedal deflection and the side slip
7 you obtain at the end. But this side slip is obtained
8 with constant bank angle, which is a significant
9 difference. We have explained that an indirect effect
10 of the use of rudder was to create roll and so
11 therefore roll rate. And roll rate -- if you do not
12 stop roll rate, the aircraft will bank, bank, bank, and
13 roll over.

14 With the fly-by-wire aircraft, when you are
15 asking just for a rudder pedal deflection, then the
16 bank will stabilize. So it's not -- it's not a roll
17 rate -- it has no effect on the roll rate. This is one
18 observed effect.

19 MR. O'CALLAGHAN: Okay. Thank you very much,
20 Mr. Chatrenet.

21 Madam Chairman, that concludes my
22 questioning.

23 CHAIRMAN CARMODY: Thank you, Mr.
24 O'Callaghan. Before I move to the parties, are there
25 any additional questions from the Technical Panel?

1 (No response)

2 CHAIRMAN CARMODY: All right. Then I will
3 move forward. Just for purpose of preparation and
4 expediting the procedure, I will -- I will tell you the
5 order of the parties that I will use today. I'm going
6 to start with the FAA and then American and then Allied
7 Pilots, finishing up with this witness for Airbus. So
8 may I ask the FAA to begin?

9 MR. DONNER: Thank you, Madam Chairman. FAA
10 has no questions.

11 CHAIRMAN CARMODY: I like to hear that.
12 Thank you, FAA.

13 MR. DONNER: I plan to repeat it several
14 times.

15 (Laughter)

16 CHAIRMAN CARMODY: I'll move now to American.
17 Mr. Ahearn, please.

18 CAPT. AHEARN: Thank you, Madam Chairman. I
19 do have a few questions.

20 Let me start off with a little bit of the
21 evolutionary process of the B2-B4 aircraft moving to
22 the 300-600 aircraft. Can you tell me, Mr. Chatrenet,
23 why the variable lever arm was originally chosen for
24 the B2-B4 aircraft?

25 MR. CHATRENET: So as I said, I was not yet

1 in the handling quality and flight control business at
2 the time of the design of the A-300-600-R, so I was not
3 yet also at the time of the B2-B4 design area. But as
4 far as I've been told, the choice of the VLA was some
5 kind of legacy coming from the experience of the
6 initial partners that started the Airbus story, mainly
7 the British one and the Sud Aviation one.

8 CAPT. AHEARN: Okay. And even though this is
9 somewhat from a historical perspective, are you aware
10 of whether or not the RTL was considered for the B2-B4?

11 MR. CHATRENET: I'm not aware of that. But I
12 could not guarantee because this is only from memory
13 from other people in charge of this at this time.

14 CAPT. AHEARN: Okay. And let me offer that
15 question to Mr. Van den Bossche as well. I believe he
16 stated earlier that he was part of the system design?

17 MR. VAN den BOSSCHE: Yes. Some years
18 before. So I was involved in the system, and by the
19 way, I was in charge of the development of this
20 particular variable lever arm unit. But I have not
21 been involved in the architecture story in the --
22 studies coming to that choice on this time.

23 CAPT. AHEARN: Okay. Let me -- maybe I
24 should direct the questions to you because you were
25 involved at the time. Are you familiar with whether or

1 not the RTL system was considered for the B2-B4?

2 MR. VAN den BOSSCHE: I think comparison had
3 been made by somebody at this time.

4 CAPT. AHEARN: And do you know why it was not
5 chosen?

6 MR. VAN den BOSSCHE: No.

7 CAPT. AHEARN: Do you know if any other
8 systems were considered other than the -- the two
9 aforementioned?

10 MR. VAN den BOSSCHE: As far as I know, a
11 review of existing systems in the industry at the time
12 has been performed.

13 CAPT. AHEARN: Okay. And again, I'll direct
14 this question to either one of you gentlemen. You can
15 choose who answers it, if that's okay.

16 But in looking at the B2-B4 as part of the
17 investigation, we have quite a bit of data on the A-
18 300-600 and the force gradients that are used. Have
19 you provided or do you have the B2-B4 force gradients
20 available as part of this investigation to show the
21 differences as to how this airplane evolved from model
22 to model?

23 MR. VAN den BOSSCHE: What -- what -- I have
24 no figure like this. Maybe -- maybe, Dominique, you
25 have.

1 But basically, what we know is that the yaw
2 control forces have been reduced between the B2-B4 and
3 the A-300-600-R, in comparative ratio that the forces
4 have been reduced on the roll axis when going from the
5 B2-B4 to the -- to the A-300-600-R.

6 And as we had a good experience with the
7 ratio we had on the B2-B4 between yaw and roll, we have
8 kept basically the same ratio between the -- the yaw
9 forces when going from the B2-B4 to the -- to the A-
10 300-600-R.

11 CAPT. AHEARN: Okay. One last question on
12 the B2-B4, and that is the breakout forces.

13 MR. VAN den BOSSCHE: Yes.

14 CAPT. AHEARN: Do you know what the breakout
15 forces -- we know the breakout forces on the 600 are
16 approximately 22 pounds. Do you know what the breakout
17 forces are on the B2-B4?

18 MR. VAN den BOSSCHE: It was the same.

19 CAPT. AHEARN: Same, 22 pounds?

20 MR. VAN den BOSSCHE: By the way, I found the
21 figures. The maximum force on the B2-B4 was 125
22 pounds. Breakout was at 22.5, which is identical to A-
23 300-600. That's for rudder.

24 CAPT. AHEARN: Okay. And Mr. Chatrenet, you
25 testified earlier that on the roll axis that the roll

1 control were approximately 30 percent lighter on the
2 600 from the previous model, the B2-B4. I assume
3 that's throughout the flight envelope so that at 250
4 knots I would anticipate that the full deflection is
5 approximately 70 percent of what it was in the B2-B4,
6 is that correct?

7 MR. CHATRENET: No. The control forces for a
8 given control wheel displacement have been reduced by
9 30 percent. But at the same time, the roll efficiency
10 has been increased when going from the B2-B4 to the A-
11 300-600 thanks to better use of the spoilers.

12 So at the same time we have reduced the
13 control forces on the roll axis and we have increased
14 the roll efficiency.

15 CAPT. AHEARN: Therefore, 250 knots, do you
16 have any sense of the force required on the 600
17 relative to the B2-B4?

18 MR. CHATRENET: On -- on the roll axis?

19 CAPT. AHEARN: On the roll axis, yes.

20 MR. CHATRENET: On the roll axis --

21 CAPT. AHEARN: Yes.

22 MR. CHATRENET: -- they have been -- the
23 amount of forces on the A-300-600 for a given control
24 wheel deflection are 70 percent of the forces needed
25 for the same control wheel deflection on the B2-B4.

1 CAPT. AHEARN: Okay. Now let's move to the
2 rudder for a moment and the transition from the B2-B4.
3 Because it's my understanding that the B2-B4 rudder
4 deflection, you would have the same feel throughout the
5 flight envelope, that you in essence would have four --
6 four inches of rudder deflection throughout the same --
7 throughout the flight envelope, is that correct?

8 MR. CHATRENET: The B2-B4 has a VLA system,
9 yes.

10 CAPT. AHEARN: Okay. And then when you
11 transition to the 600, the -- the -- the pedal movement
12 changes and it changes throughout the flight envelope.

13 As an example, at 165 knots, I believe it is a four-
14 inch deflection. And then at the 250 knot, it's
15 approximately 1.3. And then at cruise, it is
16 significantly less than that, is that correct?

17 MR. CHATRENET: In terms of displacement,
18 yes, it is correct.

19 CAPT. AHEARN: Okay. So from a control
20 harmony standpoint, when you showed a slide earlier
21 that talked about control -- flight control harmony
22 between the roll moment and the pedal moment throughout
23 the flight envelopment, you were actually really
24 talking about the speed at 165 knots, were you not?
25 That there really isn't control harmony between the

1 roll moment as well as the rudder moment throughout the
2 flight envelope, is that correct?

3 MR. CHATRENET: It's correct at 165 knots.
4 But later on, at higher speed, we maintain, if you
5 like, the same ratio between the control wheel and the
6 ailerons and between the rudder pedals and the rudder
7 deflection, which means that basically you have to
8 adapt your control deflection as speed builds up in the
9 same way in roll and yaw axis.

10 CAPT. AHEARN: And that is significantly
11 different than the B2-B4 which is where you received
12 much of your commentary about the control harmony when
13 you developed the 300 system, correct?

14 MR. CHATRENET: On the B2-B4 at higher speed,
15 yes, the -- you had the effect of the VLA.

16 CAPT. AHEARN: Let's move to the rudder
17 system. Talking about the A-300-600 airplane, in
18 designing the rudder traveler limit, did you determine
19 -- how did you determine if an average pilot could make
20 small force or displacement inputs on that airplane?

21 MR. CHATRENET: Yes, of course. Of course.
22 We have made -- so maybe flight -- maybe testing first
23 on the simulator. And later on this has been confirmed
24 by many hours of flight testing.

25 We have tested many maneuvers during the --

1 the -- what we call the "mise-en-point" period of the
2 aircraft, during the certification exercise, during the
3 demonstration to the potential customers. And for this
4 purpose we have made many maneuvers which require the
5 use of the rudder pedal, including the use of the
6 rudder pedal at high speed. And for instance, the
7 performance flight testing which requires to show the
8 performance of the aircraft when engine out is covering
9 the -- the wall flight envelope including the clean
10 condition speed as high as 250 knots -- and so on.

11 So we have made a comprehensive set of
12 maneuvers which are representative of maneuvers that
13 might be expected in airline.

14 On top of that, I mentioned already the --
15 how we tune the model. For tuning the model versus
16 flight test, we make dedicated flight tests which are
17 called data package flight testing. And this -- the
18 data package flight test includes many maneuvers where
19 we needs -- where we ask the pilot to obtain a precise
20 side slip without the flight envelope including at high
21 speed.

22 So we have tested the aircraft both in normal
23 operation, both in I would say extranormal operation,
24 including in the speed range we are considering, so
25 including the speed range where the TLU affect the

1 rudder pedal behavior. And we never had any difficulty
2 for the pilot to obtain this kind of precise, precise
3 closed loop pilot input or control input.

4 CAPT. AHEARN: And could you comment a little
5 bit more on the high speed tests? Were there any
6 conclusions from that high speed test that addressed
7 the issue of -- excuse me, rudder pedal sensitivity,
8 specifically at this speed? In other words, where you
9 are going into what I'll define as a steady heading
10 side slip. How did you or did you get multiple data
11 points throughout the flight testing at a speed of
12 approximately 250 knots?

13 MR. CHATRENET: Yes, we have -- we have
14 several points which -- which require to fly at 250
15 knots and to get specific side slip, and we never had
16 any adverse comment of our pilots -- pilots in order to
17 get this side slip.

18 CAPT. AHEARN: And in getting that side slip,
19 they were able to do that at 250 knots at full rudder
20 deflection, or you have -- interim points or
21 intermediate points?

22 MR. CHATRENET: No, we ask them to perform
23 some kind of closed loop inputs in order to get a
24 desired side slip. So this included intermediate
25 rudder pedal deflection at 250 knots or around.

1 CAPT. AHEARN: Okay. Let me just address the
2 force. We have addressed the distance of 1.3 inches.
3 How about the forces of 10 pounds or less with breakout
4 force of 22 pounds?

5 MR. CHATRENET: Please say again?

6 CAPT. AHEARN: You've -- you've addressed the
7 issue of distance, the movement of the rudder pedals to
8 approximately 1.3 or less than 1.3 inches. At the same
9 time, you are calling upon the pilot to use very light
10 forces on the rudder pedals on this airplane. In fact,
11 at the air speed that this airplane was flying at, 250
12 knots, you have a breakout force of 22 pounds and a
13 total deflection at 32 pounds, which means to get to
14 full stop you only have to apply, after breakout,
15 putting the force of 22 pounds on, an additional 10
16 pounds to get the full -- to full deflection. Do you
17 have any data points that show how you tested
18 throughout this flight envelope as well?

19 MR. CHATRENET: We have -- we have also a
20 data package flight testing plus the certification
21 flight testing.

22 Once again, when you have cited the
23 displacement, first, the displacement was either 1.4 or
24 1.3 inches. It is only the displacement of one pedal.
25 So you have to remember that the actual differential

1 movement is twice as high as that. And the pilot is
2 probably more -- more sensitive to the displacement.

3 Nevertheless -- nevertheless, when talking
4 about closed loop control input, the displacement by
5 itself doesn't matter a lot. We have made several
6 research activity according to which we can still have
7 the -- the displacement. We can still reduce the
8 displacement by the factor of two without any
9 impairment of the capability of the pilot to provide
10 for precise, precise closed loop pilot input. So it is
11 not a question of displacement.

12 Now, if we are talking about the ratio
13 between breakout forces and -- and the forces needed to
14 obtain a given objective or a given aircraft outcome,
15 the first thing is that the breakout force must be
16 sufficiently high to make the pilot fully aware that it
17 is starting to do something because there is -- it
18 should not be very good for the aircraft if just by
19 putting some inadvertent pressure on your pedal you
20 would move the rudder.

21 So the first thing is that this threshold
22 must be positive information that you start to do
23 something. Now, when you have start to do something,
24 you have applied 22.5 pounds. And then you can adjust.

25 And what we have seen up to now, that this -- the

1 gradient we have between two -- 22.5 pounds and
2 whatever is associated to the limitation or to the
3 maximum deflection is pretty appropriate for allow --
4 allowing the pilot to make precise, precise piloting.

5 You know, precise piloting is generally
6 associated with light forces. High forces are
7 detrimental to a very precise because you have to apply
8 forces and in some occasion to maintain them for a long
9 period of time, and then you lose in terms of
10 precision.

11 CAPT. AHEARN: Let me ask one final question
12 on this issue as it relates to the pilot's ability to
13 make fine -- fine movements of the pedals. What type
14 of testing did you do in turbulent air?

15 MR. CHATRENET: In turbulent -- in turbulent
16 air, we -- we fly the aircraft obviously in turbulent
17 -- in turbulent air. Generally, we find the highest
18 turbulence when we make the icing flight testing. And
19 in this case, there is no need for the pilot to act on
20 the rudder pedal. In turbulent air, the yaw damper is
21 working. The yaw damper is designed for that. And it
22 is -- there is no need for the pilot to -- to work on
23 the rudder pedals to, I would say, improve the behavior
24 of the aircraft in turbulent air. Just let the yaw
25 damper work for you.

1 CAPT. AHEARN: So, am I to interpret that
2 your interpretation that a pilot flying in turbulent
3 air should not use the rudder pedals at all?

4 MR. CHATRENET: It is not needed.

5 CAPT. AHEARN: And they shouldn't use them at
6 all?

7 MR. CHATRENET: I think I'm -- I'm not the
8 most appropriate witness to discuss this, but as a
9 design principle or a design responsible, we are
10 designing the yaw damper for the purpose of no need of
11 the pilot to fly on the rudder pedal in turbulence.

12 CAPT. AHEARN: Okay.

13 MR. CHATRENET: It is the way we are
14 designing the yaw damper. And for instance, we have
15 been refining the -- the yaw damper, fine tuning the
16 yaw damper, especially to provide better -- to
17 turbulence of the aircraft, for instance, which means
18 that basically it should be left to the yaw damper to
19 do this work.

20 CAPT. AHEARN: So in the case of where you
21 dispatch an --

22 CHAIRMAN CARMODY: Excuse me. Mr. Ahearn,
23 unless you're through with that, I think he has
24 answered that question where -- you can move on to
25 another question.

1 CAPT. AHEARN: I was just going to ask him
2 one more question about yaw damper out of service,
3 ma'am.

4 CHAIRMAN CARMODY: All right.

5 CAPT. AHEARN: Okay. In the case of where
6 you have yaw damper out of service, you would -- you
7 would certainly recommend utilization of the rudders at
8 that point?

9 MR. CHATRENET: In case of a complete yaw
10 damper failure?

11 CAPT. AHEARN: Correct. Or dispatched. I
12 mean, you can dispatch the airplane without the yaw
13 dampers in service.

14 MR. CHATRENET: In case of yaw damper
15 failure, we first recommend -- in case of total yaw
16 damper failure, remember, the system is -- is a
17 duplicate system. So it's a double redundant system.

18 In case of a total yaw damper failure, we
19 first recommend to reduce the altitude and the flight
20 envelope aircraft -- of the aircraft in order to get in
21 area where the natural damping of the aircraft is
22 better than in attitude. So this is the first thing.

23 The second thing that we recommend to -- to
24 damp any oscillation that might result from flying into
25 turbulence through the control wheel only. Through the

1 control wheel.

2 CAPT. AHEARN: And obviously, if that is not
3 effective, you would recommend utilizing the rudder,
4 correct?

5 MR. CHATRENET: So we do not recommend to use
6 the rudder.

7 CAPT. AHEARN: Okay. Well, --

8 MR. CHATRENET: This could be discussed
9 later. It is more an operational matter.

10 CAPT. AHEARN: I agree.

11 CHAIRMAN CARMODY: Yes. We -- we've
12 exhausted this one. Let's move on.

13 CAPT. AHEARN: Let me just ask one question
14 regarding the fixed ratio system. You alluded to
15 earlier that the fixed ratio system was safer than the
16 VLA or ratio changer. Could you just explain why you
17 believe that?

18 MR. CHATRENET: Please, could you rephrase
19 your question?

20 CAPT. AHEARN: I believe in your presentation
21 earlier that you represented that the fixed ratio
22 system or the rudder travel limiter was safer than the
23 VLA or ratio changer. Could you explain why?

24 MR. CHATRENET: No, I have not said that. I
25 have said that the failure cases were less severe with

1 the fixed ratio and TLU system. But I have not made
2 any qualification about safety.

3 CAPT. AHEARN: Okay. Thank you. Let me move
4 on to another area of questioning, please.

5 From a design standpoint, can the rudder
6 operating system be designed to limit or reduce loads
7 on the vertical stabilizer?

8 MR. CHATRENET: It is not done that way. We
9 select an architecture of the system, and then the
10 loads are computed accordingly. And the witness in
11 charge of loads will explain how we start from the
12 design of the system as -- as selected according to
13 handling qualities and to flight control design
14 criteria and then the loads for load. And then the
15 loads are computed accordingly.

16 So if we select this system, we compute the
17 loads accordingly. If we select another system because
18 we think that another system is most appropriate or
19 more appropriate, then the loads will be computed in
20 another way.

21 But the -- the loads computation do not drive
22 the design of the flight control system. It is not
23 this way around. It is the other way.

24 CAPT. AHEARN: Okay. So that's not on the
25 Airbus, the A-300-600. Would you -- would a yaw

1 damping system that cannot be overridden limit side
2 slip? Would you agree to that?

3 MR. CHATRENET: Excuse me?

4 CAPT. AHEARN: A yaw dampening -- if you had
5 a yaw dampening system on the airplane that could not
6 be overridden, would that in fact limit side slip?

7 MR. CHATRENET: This is basically the
8 question I had earlier, and we have no -- no simulation
9 to support this kind of -- of assumption because the
10 aircraft is not designed like that. So we cannot
11 substantiate any -- any answer.

12 CAPT. AHEARN: You alluded to 9000, I
13 believe, of 12,000 airplanes flying that have a similar
14 system to what you described as the system on the
15 Airbus 300-600. Are you familiar with how many of the
16 airplanes of those 9000 have a yaw dampening system
17 that cannot be overridden to limit side slip?

18 MR. CHATRENET: No, I am not well aware of
19 the -- of the architecture of these -- these aircraft.

20 CAPT. AHEARN: How about a -- a hinge moment
21 limiter or what is commonly referred to as rudder
22 blowdown?

23 MR. CHATRENET: Mm-hmm.

24 CAPT. AHEARN: Would that also limit the side
25 slip of an aircraft?

1 MR. CHATRENET: The -- the blowdown principle
2 is -- is similar to the TLU. It's simply because once
3 the -- assuming that the hinge moments are linear, it
4 will give a natural stop of the rudder deflection as a
5 function of -- of the air speed of the aircraft.

6 CAPT. AHEARN: Okay. And again, are you
7 familiar with, of the 9000 airplanes that you
8 represented earlier, how many of them have a blowdown
9 system -- rudder blowdown system?

10 MR. CHATRENET: To my knowledge, I think that
11 the 737 has a kind of blowdown system with a fixed
12 ratio type.

13 CAPT. AHEARN: Okay. So that would be
14 included in the 9000?

15 MR. CHATRENET: Yes, yes.

16 CAPT. AHEARN: Okay. How many hydraulic flow
17 restrictor -- obviously, that -- that -- again, same
18 type of question. Would a hydraulic flow restrictor
19 limit the rudder rate -- reduce loads -- thereby
20 reducing loads on the vertical stabilizer?

21 MR. CHATRENET: I think that, from a -- from
22 a design point of view, the -- the flow restrictor is
23 -- is needed when you have no TLU, no physical
24 limitation. If you have a physical limitation, like an
25 RTL or limit, the flow restrictor is not necessary.

1 You get the limitations through the RTL.

2 It's once you don't have any RTL, and as your
3 system on most big transport aircraft are at least
4 double redundant, you must provide sufficient
5 deflection with only one system -- one hydraulic system
6 operative, which means that generally you have two
7 system operative. And if you are just relying on the
8 hinge moment to limit your system as natural, then you
9 use flow restrictor to reduce the maximum rudder
10 deflection. But if you have an RTL, it is not
11 necessary.

12 CAPT. AHEARN: So then, the -- obviously, the
13 A-300 only has the RTL. Are you aware of any other
14 transport category aircraft with the hydraulically-
15 powered rudder that does not incorporate at least one
16 of these features that we mentioned? That being either
17 the hydraulic restrictor, blowdown or -- or a yaw
18 dampening system that cannot be overridden? Other than
19 the A-300.

20 MR. CHATRENET: Please, could you -- could
21 you make your question precise on this aspect?

22 CAPT. AHEARN: Sure. We talked through a
23 number of secondary protection that would be available
24 to the manufacturer should they choose to use them, one
25 being a yaw damper system that can't be overridden, one

1 being a -- a hinge moment limitation or rudder
2 blowdown, and the last was a hydraulic flow restrictor.

3 I believe that most of the 9000 airplanes that you
4 alluded to earlier have at least one of those secondary
5 protections in their system. The A-300-600 does not.

6 Are you aware of any other air transport
7 aircraft with a hydraulically-powered rudder that
8 doesn't incorporate at least one of these features
9 other than the A-300-600 and the A-310?

10 MR. CHATRENET: If you are referring to the
11 flow restrictor, as far as I know the flow restrictor
12 are fitted on the 737 where there is no RTL. So it is
13 a substitute of the RTL. So we think that through the
14 use of the RTL we do not need flow restrictors.

15 So I think that the comparison is not exactly
16 relevant in this case. So you cannot say, for
17 instance, that a flow restrictor is an additional
18 precaution. It's not -- it's only a substitution for
19 no RTL. Once you have an RTL, it is not necessary to
20 put a flow restrictor.

21 CAPT. AHEARN: Okay. Let me -- let me try
22 the question in a different approach. Are you aware of
23 any other transport category aircraft other than the A-
24 300-600 or the A-310, which are the only aircraft with
25 this type of rudder control system, that have

1 experienced rudder doublets or triplets resulting in
2 loads that exceed ultimate load?

3 MR. CHATRENET: I think that I cannot agree
4 with the -- with the terms of your question.

5 CAPT. AHEARN: Okay. Well --

6 MR. CHATRENET: Because -- no. We will have
7 to -- to address this aspect during the loads -- the
8 loads presentation because you have -- you have made
9 some assumptions in your questions.

10 CAPT. AHEARN: Okay. Can you clarify those
11 assumptions? All I'm looking for is that this, to me,
12 appears to me to be the only aircraft of this type that
13 has experienced rudder doublets or triplets resulting
14 in loads that have exceeded ultimate load. Are you
15 aware of any other aircraft types that have experienced
16 doublets or triplets resulting in an exceedance of
17 ultimate load? Because I'm not.

18 MR. CHATRENET: In -- in history, what --
19 what do you mean that -- whether we know if other
20 aircraft of other manufacturer have experienced during
21 their in-service life some high loads events? We have
22 not access to any database. I don't know even if these
23 databases exist to be in a position to tell you that we
24 have reviewed all these databases of all aircraft
25 flying and we can say or we cannot say if other

1 aircraft have also experienced high loads. That's
2 simply because the database does not exist and we
3 cannot qualify the -- the loads history of the aircraft
4 which have not been built by Airbus.

5 We can know what is the -- the -- the history
6 of the records of our fleet but not the fleet of other
7 manufacturers. So I think we cannot -- we cannot
8 provide you with -- with -- with, say, a good answer to
9 this question.

10 CHAIRMAN CARMODY: Thank you. Yes. The
11 witness has answered this question sufficiently, Mr.
12 Ahearn. Obviously, he can't give you the answer you're
13 looking for or he's not comfortable with the
14 assumptions. And I understand that. I think you
15 should move on to another area, or perhaps you're
16 finished.

17 CAPT. AHEARN: I'm just going to move on to
18 one other --

19 CHAIRMAN CARMODY: All right. Thank you.

20 CAPT. AHEARN: Thank you.

21 CHAIRMAN CARMODY: If you need to address
22 this question to other witnesses, that may be
23 appropriate. But I think we've beaten this one to
24 death.

25 CAPT. AHEARN: Thank you, ma'am.

1 CHAIRMAN CARMODY: Thanks.

2 CAPT. AHEARN: Let me refer to Exhibit 9-B,
3 page five. And if we could bring that up on the
4 monitor, please?

5 (Slide)

6 CAPT. AHEARN: Just a couple questions on
7 this one, Mr. Chatrenet or Mr. Van den Bossche.

8 I just want to make sure I understand. When
9 -- when you're looking at this chart, does this chart
10 not show the yaw damper moved in such a manner that it
11 increased the rudder rate and motion beyond what was
12 commanded by the pedals?

13 MR. CHATRENET: The yaw damper is acting
14 against the yaw rate. So it's fighting against the yaw
15 rate. So by no means the yaw damper can increase the
16 yaw rate coming from the rudder pedal. So normally it
17 is fighting against it.

18 CAPT. AHEARN: Okay. I would agree with you
19 in the first movement of the pedals. But as you
20 continue to get multiple movements of the pedals, the
21 second movement and the third, they appear to become
22 more in line with the pedal movement.

23 (Pause)

24 MR. CHATRENET: No. In this -- in this area,
25 for instance, once you get the maximum -- the maximum

1 deflection, then, first the yaw rate has not started to
2 -- to -- we should get in this figure the yaw rate. We
3 don't have the yaw rate. But basically, the yaw damper
4 provides something which is basically proportional and
5 opposed to the yaw rate.

6 So we cannot see how this deflection can be
7 in the same sign of the yaw rate. We do not see the
8 yaw rate on -- on this. So just what we say is that at
9 this time, at this time of rudder reversal --

10 MR. VAN den BOSSCHE: The pointer -- there is
11 no pointer.

12 MR. CHATRENET: Okay. There is no pointer.
13 Maybe on the --

14 CAPT. AHEARN: On the slide that you have
15 there -- I don't know if you're looking at the same
16 slide, but it should be on your monitor in front of
17 you. The lighter --

18 MR. CHATRENET: We could --

19 CAPT. AHEARN: -- yellow -- I'm sorry. The
20 lighter green line is the yaw dampener movement.

21 MR. CHATRENET: If you allow me, I would show
22 a slide where I can have the point --

23 CHAIRMAN CARMODY: Would you identify the
24 slide we are looking at just for everyone's --

25 CAPT. AHEARN: Yes, ma'am. It is Exhibit 9-

1 B, page five.

2 CHAIRMAN CARMODY: Right. Okay. And we
3 looked at this quite a bit earlier, as I recall.

4 CAPT. AHEARN: We did. Yes, ma'am. I just
5 have two questions.

6 CHAIRMAN CARMODY: Mm-hmm.

7 MR. CHATRENET: So -- okay. At the time of
8 this reversal, the yaw rate was still resulting from
9 the last rudder application. And the yaw damper was
10 fighting against it. Just at the time when it is
11 reversed, the yaw rate has not yet enough time to build
12 up. So basically, you see a rudder and yaw damper in
13 the same direction. But as soon as the rudder has
14 sufficient time to cause a yaw rate to establish, then
15 you see the yaw damper which will act against --
16 against the rudder pedal deflection in order to damp
17 the yaw rate.

18 So I think simply we are missing on this
19 figure the yaw rate which -- to -- to show that
20 basically the yaw damper is acting against the yaw rate
21 every time. It is not -- not increasing or -- or
22 amplifying the yaw rate which is commanded by the
23 rudder.

24 CAPT. AHEARN: Okay. So maybe we need to add
25 that to this chart to see what's going on because it

1 does appear that it is increasing the rudder movement.

2 MR. CHATRENET: It's simply because the --
3 the rudder reversal at the first instant, this rudder
4 deflection will just call -- will just cause yaw rate
5 derivative, yaw rate acceleration. And then this
6 acceleration around the yaw axis has to be integrated
7 before it generated -- generates yaw rate. And then,
8 when the yaw rate speeds up, then you see the yaw
9 damper to act against it.

10 But you need an integration so you have a
11 time constant in between.

12 CAPT. AHEARN: Okay. So we need to -- we
13 need to add another line to this chart in order to see
14 if in fact the yaw damper is working with or against
15 the pilot commands?

16 MR. CHATRENET: It might help. But this
17 would be discussed with the NTSB as well, too, to
18 substantiate that. Basically, this -- this yaw rate
19 has been reconstructed by the NTSB. We have made the
20 same computation and we obtained very close -- very
21 close results.

22 CAPT. AHEARN: Okay. Your movement of the
23 arrow actually goes to my next question, which is,
24 between 8:47 and 8:48, it appears that -- on my chart
25 it's a light yellow line, but you know which one is the

1 yaw damper movement -- that this line goes flat at
2 8:49. Do you have any reason or any understanding as
3 to why this movement failed? Could it be that it
4 possibly wasn't keeping up with acceleration?

5 MR. CHATRENET: Basically, we reached at this
6 stage a maximum authority of the yaw damper, which is
7 around 4.3 degree, likewise explained by Dominique Van
8 den Bossche this morning.

9 CAPT. AHEARN: Okay. So that --

10 MR. CHATRENET: So it is saturated by the yaw
11 rate simply because the yaw rate asked for the maximum
12 deflection. We see it here. We see it there.

13 CAPT. AHEARN: So that --

14 MR. CHATRENET: After that time, I'm not --
15 I'm not confident about all the simulation which are
16 done beyond -- beyond this point, which is the
17 estimated point of puncture. But assume that the yaw
18 rate at this stage is sufficiently high to saturate the
19 -- the yaw damper authority.

20 CAPT. AHEARN: Okay. And then, Madam
21 Chairman, just one final question, please.

22 Could you tell me how Airbus determined how
23 much rudder was needed at higher speeds? Basically,
24 what I'm going to is you had a -- you had a gradient on
25 one of your charts earlier that showed you'd have 30

1 degrees of deflection at about 165 knots. At the 250
2 knot speed, you had approximately 9.8, I believe. And
3 then at cruise it was approximately 3.5.

4 What I'm really looking for is how is that
5 gradient developed?

6 MR. CHATRENET: So this -- this gradient was
7 developed by computing for each speed -- for each speed
8 what was the static rudder deflection which was needed
9 to compensate for an engine failure with wind level.

10 CAPT. AHEARN: So it's purely on engine out?

11 MR. CHATRENET: It's engine out plus -- plus
12 an adequate margin for allowing the yaw damper to work
13 on both sides plus and minus around this value.

14 CAPT. AHEARN: Do you have any idea why it
15 would be so large at 250 knots, the 9.2 or 9.8 degrees?

16 I don't remember what the number was exactly. But
17 that's -- that's about a third of the full rudder
18 deflection at a substantial speed.

19 What I'm referring to, and I know this is not
20 your area of expertise. It may be something else that
21 we'll talk to one of the other witnesses about. But in
22 an FCOM that was put out by Airbus, it talks about at
23 high speeds to accommodate an engine out, the amount of
24 rudder required to counter an engine failure and center
25 the side slip is small. I don't know that I would

1 really call 9.8 or 9.2 degrees of deflection "small."
2 And I'd appreciate you commenting on why the RTL allows
3 so much rudder deflection at 250 knots?

4 MR. CHATRENET: We have proposed this morning
5 to add to the record a technical note which justifies
6 this -- this selection of the RTL by the universal
7 speed. Remember that at this speed, around 250 knots,
8 for instance, from memory, it basically should need
9 seven degree of rudder to compensate for the engine
10 failure and three degree for the yaw damper activity,
11 something around there, or six plus four, something
12 like that.

13 So it's not the raw TLU value which is needed
14 to compensate for the engine failure. It is only part
15 of it in order to keep the margin for the yaw damper to
16 operate beyond this value.

17 CHAIRMAN CARMODY: Mr. Ahearn, was that your
18 last question?

19 CAPT. AHEARN: Yes, it is, Ms. Carmody.
20 Thank you very much.

21 CHAIRMAN CARMODY: All right. Thank you.
22 Now we move to Allied Pilots, please.

23 CAPT. PITTS: Good afternoon.

24 CHAIRMAN CARMODY: Capt. Pitts.

25 CAPT. PITTS: Gentlemen, earlier today you

1 commented that both the variable ratio and the variable
2 limit systems as used on the rudder design are
3 certified. The 605-R model, the aircraft in question,
4 has a variable limit. Can you describe for me the
5 certification basis of the dash 605-R rudder system?

6 MR. CHATRENET: The certification
7 requirements of the FAR Part 25. And there is no -- no
8 specific requirements which address -- which address
9 specifically any choice of architecture for the rudder
10 control.

11 CAPT. PITTS: So --

12 MR. CHATRENET: There are some rules to
13 compute the loads associated to the design.

14 CAPT. PITTS: So when this aircraft -- the --
15 you're telling me that the certification basis for the
16 dash 605-R is in fact the first model of the A-300
17 which you put in the field, the B2-1A?

18 MR. CHATRENET: Excuse me? The -- could you
19 -- could you say again your question?

20 CAPT. PITTS: I'm asking if the certification
21 basis of this aircraft, the dash 605-R --

22 MR. CHATRENET: Mm-hmm.

23 CAPT. PITTS: -- is in fact the first
24 aircraft you fielded, the A-300-B2-1A.

25 MR. CHATRENET: The certification, no. I'm

1 afraid I have not understood completely your question.

2 CAPT. PITTS: Well, sir, the certification
3 basis is a term of art. And if -- if we were to look
4 at the revisions of this model, we would see that the
5 B4-605-R is in fact the 17th revision of the basic
6 design.

7 MR. CHATRENET: Mm-hmm, mm-hmm.

8 CAPT. PITTS: Is that correct? And I'm
9 asking you, what was the certification basis in
10 compliance with the Part 25 requirements for
11 certification used for the B4-605-R model?

12 MR. CHATRENET: It was the regulation which
13 was in -- in force at the time of the certification of
14 this aircraft.

15 CAPT. PITTS: So the B4-605-R model went
16 through the same process for certification as the B2-
17 1A?

18 MR. CHATRENET: The B2 -- the B2-B4 was
19 certified according to the requirements that were in
20 application at the time of the B2-B4 certification.
21 And the 600-R, according to the certification
22 requirements that were in force at the time of the
23 certification of the 600-R. So it might be that there
24 have been some evolution in between. Possible.

25 CAPT. PITTS: So are you saying then that

1 there was a difference in the certification
2 requirements between the initial certification of the
3 A-300-B2-1A?

4 MR. CHATRENET: I'm not in a position to
5 identify right now from memory the differences between
6 the certification bases, but this can be found. It's
7 -- it's in the public domain.

8 CAPT. PITTS: In terms, then, of the -- the
9 change from a variable ratio to a variable limit
10 philosophy on the flight controls as it pertains to the
11 rudder, was there a revisiting of the certification as
12 was originally accomplished on the design?

13 MR. CHATRENET: There was a complete -- if
14 you like, a complete review of all the certification
15 bases that were to be applied to the 600-R. And we
16 have checked that the design, including the RTL design,
17 was satisfying the -- the certification requirement.

18 CAPT. PITTS: Okay. I'll move on. Earlier
19 today, sir, you previously mentioned roll and yaw
20 flight control force properties. I'd like to go back
21 and revisit that just a moment.

22 Were the pitch control forces also balanced
23 proportionally to such a light standard as you
24 discussed with the roll authority from the ailerons?

25 MR. CHATRENET: No, the pitch control is a

1 complete different issue. The pitch control forces,
2 first they are made variable across the flight
3 envelope. And -- and they are made variable also
4 because the condition of operation are different. I
5 mentioning the center of gravity possible variation
6 between the forward limit and aft limit.

7 So also, from -- for roll and yaw axes, the
8 variable parameter, if you like, is the speed for the
9 pitch axis on top of the effect of the speed. You have
10 the effect of the center of gravity. That's why, for
11 instance, the feel system, the artificial feel system
12 in pitch is different and a bit more complex than the
13 artificial feel system in roll and yaw.

14 CAPT. PITTS: Okay. Then, in terms of this
15 harmonious flight control handling properties that you
16 mentioned earlier today, do you consider all three axes
17 of the primary flight controls to be harmonious?

18 MR. CHATRENET: Not necessarily. I think I
19 have made -- it's important that roll and yaw axes are
20 harmonized. Pitch axis, it's -- it's a different
21 aspect. Obviously -- obviously, a good aircraft is a
22 balanced aircraft. It's -- I think there's a pitch
23 axis on one side and the roll and yaw axes on the other
24 side as a bit separated. It's different issues. The
25 maneuvers that you are performing are not exactly the

1 same. So I think they are not really comparable.

2 But for sure, roll and yaw must be made
3 consistent. Pitch is another issue.

4 CAPT. PITTS: So then, from a Airbus design
5 philosophy of the flight control, you would treat the
6 roll and yaw systems, two of the three primary flight
7 control axes, different than the pitch. Is that what
8 you are saying? From an overall design philosophy at
9 Airbus.

10 MR. CHATRENET: We would verify, I would say,
11 first separately that each axis, pitch on one side,
12 roll and yaw on the other side, have appropriate
13 characteristic. And after that, it will be an outcome
14 to see whether it is well balanced or not. But not
15 from a design point of view to say, okay, we must make
16 pitch and roll and yaw axes all together consistent.
17 It is true for roll and yaw on one side, pitch on the
18 other side. I would say at the beginning of the design
19 pretty independently.

20 CAPT. PITTS: Sir, you mentioned "appropriate
21 and consistent." Do you have an objective measure for
22 those terms in relationship to the flight controls?

23 MR. CHATRENET: So we are -- we are already
24 discussing about aspects that will be more deeply
25 covered later on. But just let me say from a design

1 point of view that we are designing the flight control
2 system with a big help and a big contribution of the
3 pilots anyway. And at several stages, at the design
4 stage, at the stage when we test the system on the
5 simulator, obviously at the stage when we test the
6 system in flight, and even after when the aircraft is
7 in service, the flight control design engineers have a
8 permanent, permanent discussion with the pilots in
9 order to check that the system is behaving like
10 expected and is providing good handling qualities of
11 the aircraft.

12 So, to my knowledge as a design responsible,
13 this type of aircraft has now something like 15
14 millions flying hours. And on this particular aspect
15 of control harmony, control sensitivity, and so on, we
16 never, never have any complaint since the entering to
17 service nor, obviously, during the design -- the design
18 period. And we even had no I would say suggestion of
19 improvement.

20 CAPT. PITTS: I see. So in -- it's your
21 testimony that Airbus has not modified any of the three
22 primary flight control systems to address any
23 unfavorable reports or handling qualities of the
24 aircraft?

25 MR. CHATRENET: Up to now we have no such --

1 we have not encountered such undesirable behavior on
2 the -- on yaw axis, for instance, that would deserve
3 some kind of addressing or modification or input on the
4 yaw axis.

5 CAPT. PITTS: And the other two axes?

6 MR. CHATRENET: On the roll neither.

7 CAPT. PITTS: So there has been no
8 modifications to the flight augmentation computers of
9 the A-300-B4-605-R to improve handling characteristics?

10 MR. CHATRENET: From -- from what is coming
11 from the pilots, there is no modification. From what
12 is coming from the yaw damper function, as far as I
13 remember, we have made some modification as an answer
14 to some request of our customer to improve the -- some
15 kind of fishtailing phenomena. And we have made some
16 modification on the yaw damper function.

17 But this is not relative to any input coming
18 from the pilot. And it was mainly to improve the comfort
19 when the aircraft is flying in cruise in turbulence.

20 CAPT. PITTS: Fishtailing. Is there another
21 term for that?

22 MR. CHATRENET: Lateral incomfort.

23 CAPT. PITTS: Lateral --

24 MR. CHATRENET: Lateral uncomfort.

25 CAPT. PITTS: Lateral uncomfort?

1 MR. CHATRENET: Lateral uncomfort for the
2 passengers sitting at the rear.

3 CAPT. PITTS: Would those be lateral
4 accelerations, sir?

5 MR. CHATRENET: Generally, it is a feeling
6 which is difficult to -- to analyze. It generally
7 comes out as a complaint. It's -- it's -- it's common
8 to many, many aircraft at the entry to service saying,
9 well, when the aircraft is riding into turbulence we
10 think that we might impose a comfort in the rear part
11 of the -- it's pretty subjective because each time it's
12 very difficult to -- to clearly make a relationship
13 between any complaint observed for the -- from the
14 passenger or the flight attendant during a dedicated
15 period of time. And generally, we do not have the FDR
16 recording at this time to say, well, it's of use. We
17 see some lateral load factors that might explain this.
18 It's more an overall subjective assessment.

19 So we had some suggestions for improvement at
20 the beginning. We have made a modification of the AVC
21 computer. And since that date and since the
22 introduction of this modification, we have no -- no --
23 any complaint in this area.

24 CAPT. PITTS: So there was a modification to
25 the flight --

1 MR. CHATRENET: There has been a modification
2 of the yaw damper, yes.

3 CAPT. PITTS: And when did that take place?

4 MR. CHATRENET: I could not recollect from my
5 memory like that.

6 CAPT. PITTS: Who was the customer that
7 complained about the fishtailing of the B4-605-R model?

8 MR. CHATRENET: I do not remember.

9 CAPT. PITTS: Are you --

10 MR. CHATRENET: But I could -- I could give
11 you the -- we could -- we could retrieve the -- from
12 memory, it was a Far East operator.

13 CAPT. PITTS: Are you familiar with numerous
14 safety reports which number in excess of 30 from our
15 pilots organization which speak to uncommanded rudder
16 inputs and concerns about those?

17 MR. CHATRENET: Please, could you --

18 CAPT. PITTS: Uncommanded rudder inputs,
19 fishtailing, lateral accelerations. Are you familiar
20 with the reports that have been included and submitted
21 for consideration in the public docket from the Allied
22 Pilots Association to concerned pilots which speak to
23 handling characteristics and concerns about fishtailing
24 on the A-300-B4-605-R?

25 MR. CHATRENET: I -- I -- I am aware of this

1 fishtailing aspect, yes.

2 CAPT. PITTS: And would those fall into that
3 subjective category that you mentioned earlier?

4 MR. CHATRENET: As long as they are relative
5 to comfort, comfort level for the passenger is a
6 subjective assessment.

7 CAPT. PITTS: All right, sir. We had some
8 earlier discussions about lateral accelerations and the
9 need to address engine failure and landing at a crab --
10 cross wind control. Is it correct that you previously
11 stated that the rudder should be used to oppose any
12 other yaw asymmetry?

13 MR. CHATRENET: The rudder is the main
14 control to correct big yaw asymmetry.

15 CAPT. PITTS: Big yaw asymmetry?

16 MR. CHATRENET: Big yaw asymmetry, like
17 engine failure.

18 CAPT. PITTS: Then, just to touch upon some
19 previous discussion, is it true that within your design
20 philosophy that the rudder is not to be used as a
21 primary flight control once in cruise or when in some
22 other situation other than a big asymmetry?

23 MR. CHATRENET: No, but it should not be used
24 like that except you can trim out any small lateral
25 asymmetry. For instance, if you have a lateral

1 asymmetry coming from an aircraft not perfectly
2 symmetrical or a small asymmetry, you can use small
3 rudder -- small rudder trim. But it's -- it is through
4 the rudder trim anyway because it is an asymmetry that
5 would build up very slowly and which requires only a
6 very small -- very small amount of rudder.

7 CAPT. PITTS: What would be --

8 MR. CHATRENET: But you can use also the --
9 the -- the roll -- the roll trim.

10 CAPT. PITTS: What would be an appropriate
11 pilot response to an in-flight yaw asymmetry in terms
12 of which flight control to use?

13 MR. CHATRENET: If he's had an engine
14 failure, it should be through the use of the rudder.

15 CAPT. PITTS: If it's a yaw asymmetry of any
16 nature, sir, which would be the flight control that a
17 pilot would be expected to use to counter yaw
18 asymmetry?

19 MR. CHATRENET: This -- this question I am
20 not the best expert --

21 CAPT. PITTS: Would --

22 MR. CHATRENET: -- from the operational side.
23 It's not really relative to the flight control design.

24 CAPT. PITTS: So would --

25 MR. CHATRENET: It's more related to the

1 operation of the flight control design and the --

2 CAPT. PITTS: So within your design
3 philosophy, you are not saying that the pilot should
4 not use the rudder to counter a yaw asymmetry. It
5 sounded like earlier that we did touch upon that.

6 MR. CHATRENET: What we have -- what we have
7 explained this morning and this afternoon is that the
8 -- the yaw damper function is there to -- to provide
9 the yaw damping and to provide the turn coordination.
10 Therefore, it is not necessary to use the rudder
11 control by itself for providing -- yaw damping or -- or
12 turn coordination.

13 For the engine asymmetry, it's obvious that
14 you are to use the rudder. And it is what the rudder
15 is designed for, compensating for engine asymmetry,
16 allowing for cross wind takeoff and landing at the
17 maximum allowed cross wind.

18 So this is -- this is what the -- the system
19 is designed for.

20 CAPT. PITTS: Okay. So it almost sounds as
21 if there is a limitation on when you would expect a
22 pilot to use the rudder, maybe primarily for engine
23 failure or cross wind landing control, is that correct?

24 MR. CHATRENET: It's a primary use of the
25 rudder.

1 CAPT. PITTS: That's the primary use?

2 MR. CHATRENET: Engine asymmetry and cross
3 wind takeoff and landing.

4 CAPT. PITTS: And how is that conveyed to the
5 pilots, sir?

6 MR. CHATRENET: This is not in my -- in my
7 field of expertise.

8 CAPT. PITTS: So when the --

9 MR. CHATRENET: It is an operational aspect.

10 CAPT. PITTS: In the conveyance of the flight
11 control philosophy to the operators, there is no
12 mention of this expectation that the yaw damper would
13 be used almost in a primary mode to deal with the
14 lateral accelerations?

15 CHAIRMAN CARMODY: Capt. Pitts, I'm not sure
16 this is a question for this witness. I think he's
17 already indicated it's not in his area. So perhaps
18 hold it for later, if you like.

19 CAPT. PITTS: I'll move off that.

20 In terms of maximum force and pilot leg
21 strength applied to the rudder, are you familiar with
22 the 300-pound or less value that's mentioned in the
23 Federal Aviation Regulations we use?

24 MR. VAN den BOSSCHE: This is the limit load,
25 yes.

1 CAPT. PITTS: And how is that force to be
2 applied and measured?

3 MR. VAN den BOSSCHE: Pardon?

4 CAPT. PITTS: In other words, the limit load
5 would be 300 pounds.

6 MR. VAN den BOSSCHE: Yes. This is the load
7 for which the mechanical system is designed for.

8 CAPT. PITTS: And you --

9 MR. VAN den BOSSCHE: -- strings.

10 CAPT. PITTS: Right. And your design has
11 chosen to use a breakout force of 22 pounds, is that
12 correct?

13 MR. VAN den BOSSCHE: Yes.

14 CAPT. PITTS: How is that force to be applied
15 and -- and at -- where is the appropriate point to
16 measure that force?

17 MR. VAN den BOSSCHE: First, that force has
18 nothing to do with handling qualities. It is just an
19 arbitrary force for designing the force strength, the
20 complete mechanical linkage. And this force is applied
21 on the pedals.

22 CAPT. PITTS: On the pedals?

23 MR. VAN den BOSSCHE: Yes.

24 CAPT. PITTS: I see. Directly on the pedals?

25 MR. VAN den BOSSCHE: Yeah.

1 CAPT. PITTS: During the measuring of forces
2 for the rudders in Toulouse earlier this year, there
3 was a discussion about the placement of the transducers
4 and they were not chosen -- there was quite a bit of
5 discussion about inappropriateness of using those at
6 the rudder pedals. Can you speak to that?

7 MR. VAN den BOSSCHE: Two sets of transducers
8 have been used for this test. NTSB test equipment was
9 using transducer on the pedals. And the others' test
10 equipment was using transducers on the control rod
11 downstream of the pedals.

12 CAPT. PITTS: And you say that that will not
13 have an impact on the handling qualities of the
14 aircraft? Differences of -- of strength values, force
15 values, and where those are measured?

16 MR. VAN den BOSSCHE: I'm not sure I
17 understand. There is a direct relationship between --

18 CHAIRMAN CARMODY: Excuse me. I can't hear
19 the witness. Would you mind speaking up? And I'm not
20 sure -- Capt. Pitts, maybe you need to restate the
21 question. I don't think it was clear.

22 CAPT. PITTS: I'm trying to understand why
23 the forces are different as they're -- as they're
24 measured at the various locations. And my
25 understanding is, is that from a design criteria those

1 forces are to be measured at the rudder pedals. And in
2 fact, Airbus practice is to use a location other than
3 the rudder pedals to measure those forces, is that
4 correct?

5 MR. VAN den BOSSCHE: Yes, but there is a
6 direct mathematical relationship between the force
7 applied on the pedals and the force applied on the rod
8 which is being used for the force measurement.

9 CAPT. PITTS: So regardless of which one we
10 use, if you apply the mathematical correction you
11 should get the same values?

12 MR. VAN den BOSSCHE: Yes, provided the force
13 is applied with the right angle.

14 CAPT. PITTS: Provided the force --

15 MR. VAN den BOSSCHE: The force is applied to
16 the -- with the right angle to the pedal because it is
17 a question of momentum rather than force.

18 CAPT. PITTS: When I put my foot on the
19 pedal, am I applying a right-angle force, sir?

20 MR. VAN den BOSSCHE: Probably.

21 CAPT. PITTS: Probably? So then, if we
22 measured it at the rod, would we be sure that we are
23 measuring the same value that a pilot might apply to
24 the rudder pedal?

25 MR. VAN den BOSSCHE: I'm coming back to this

1 issue of the 300 pounds which was the start of this
2 conversation. Three hundred pounds is the force to be
3 used for sizing strength-wise the components. For
4 doing that, we select the worst condition, which is the
5 condition for which these force produce the highest
6 momentum in the pedal assembly. The forces that
7 propose, we assume that this force is just
8 perpendicular to the arm of the -- of the pedal. And
9 this is it. This has nothing to do with handling
10 quality.

11 CAPT. PITTS: So --

12 MR. VAN den BOSSCHE: And -- what?

13 CAPT. PITTS: I -- go -- I'm sorry.

14 MR. VAN den BOSSCHE: No, go on, please.

15 CHAIRMAN CARMODY: Capt. Pitts, I think he's
16 answered the question. Do you have other
17 questions?

18 CAPT. PITTS: I -- I just wanted to make sure
19 that I understood that in his opinion that the tactile
20 feel relationship at the pedal for the pilot applying
21 force would be measured the same as the measurement
22 techniques used at the rod.

23 Would we be able to -- would we be able to
24 take that comparison forward and know what we're asking
25 the pilot to do as they apply force to that rudder

1 pedal?

2 MR. VAN den BOSSCHE: Well, for making this
3 comparison, we probably need more that -- like the
4 angles, as I said before.

5 CAPT. PITTS: Okay. Going back to the VSA
6 and the electrical motors, you said that a force of 120
7 pounds could stall the function of this electrical --
8 this electrical motor which drives the VSA, is that
9 correct?

10 MR. VAN den BOSSCHE: Correct.

11 CAPT. PITTS: And that would impact the
12 rudder travel limiting system, is that correct?

13 MR. VAN den BOSSCHE: It would prevent the
14 limiting system to further move, but the limiting
15 system would remain irreversible.

16 CAPT. PITTS: Would it adversely impact the
17 rudder travel limiting system?

18 MR. VAN den BOSSCHE: It would prevent the
19 limiting system to move toward any -- any air speed
20 configuration, if you like.

21 CAPT. PITTS: So if it failed to move to a
22 higher speed configuration it would in fact be --

23 MR. VAN den BOSSCHE: That -- it would -- at
24 least it would -- it would allow to keep it at the same
25 position.

1 CAPT. PITTS: Would that be considered an
2 adverse effect on the rudder travel limiting system,
3 sir?

4 MR. VAN den BOSSCHE: No. And beyond that,
5 there is a monitoring function which compares the
6 achieved position of the rudder limiting system with
7 the command. And as long as the command exceeds a
8 certain threshold, which is five millimeters -- the --
9 the warning is displayed.

10 CAPT. PITTS: I'm not sure I understand,
11 then. So you're saying --

12 CHAIRMAN CARMODY: Capt. Pitts, Capt. Pitts,
13 I think we've done quite enough in this line of
14 questioning. If you have something else, let's ask it.

15 If not, I'd like to move on to the last party. The
16 hour is 4:30. We've spent a lot of time on these same
17 issues, and I think the witnesses have answered to the
18 best of their ability. And I think we've done enough
19 on this subject.

20 CAPT. PITTS: I apologize, Madam Chairman.
21 It's a very complex system --

22 CHAIRMAN CARMODY: I know it is.

23 CAPT. PITTS: -- and in -- in terms of what
24 we've heard today, there's been quite a bit of
25 discussion about simulations. There are some

1 references to some theoretical positions on the 9-B,
2 page five chart that I'd like to address. And I'm not
3 sure --

4 CHAIRMAN CARMODY: Is this coming to the end
5 of your questioning?

6 CAPT. PITTS: There are several more.

7 CHAIRMAN CARMODY: All right. Well, I'd like
8 you to limit them because I do think we've spent a lot
9 of time on this and I think other witnesses may be able
10 to address this better. And I think we need to move
11 forward.

12 Which is the exhibit you're referring to now?

13 CAPT. PITTS: Exhibit 9-B, page five. The
14 chart of the --

15 CHAIRMAN CARMODY: We've looked at this -
16 -

17 CAPT. PITTS: -- rudder position. Could you
18 bring that up for us, please?

19 (Slide)

20 CAPT. PITTS: Sir, in -- using the digital
21 flight data recorder time stamp of approximately
22 8:43.5, in your earlier statements you mentioned a
23 theoretical limit there. Could you explain that in
24 just a little more detail? I did not catch the exact
25 meaning of what you meant by the red line with the

1 square -- squared off top as being a theoretical value.

2 MR. CHATRENET: Are you talking about this --
3 this curve?

4 CAPT. PITTS: Yes. The Airbus simulated
5 rudder position red line --

6 MR. CHATRENET: Yes.

7 CAPT. PITTS: -- 8:43.5. Yes, sir, right
8 there. That squared sign.

9 MR. CHATRENET: This point?

10 CAPT. PITTS: Yes. Yes. Did you reference
11 that as a theoretical point, theoretical limit earlier,
12 sir?

13 MR. CHATRENET: We believe it is the best
14 knowledge we can have of the rudder deflection at this
15 stage because both it provides a good matching with the
16 motion of the aircraft on one side, and secondly, when
17 it is filtered like the stack is filtering the signal,
18 it is perfectly matching with the recorded point on the
19 DFDR.

20 CAPT. PITTS: Did that match all of the other
21 values? When you mentioned it had a good match, did it
22 match all other values closely?

23 MR. CHATRENET: Yes. All -- all of the other
24 parameters. We have just shown some of them, like NY
25 and heading. But it is also true for bank angle, pitch

1 attitude, and so on. So we have a -- I would say a
2 perfect match between the rudder position and more
3 generally between the rudder position, for instance,
4 and the filtered value in the DFDR.

5 And we have what we call an essential match
6 between the flight parameters from the simulation on
7 one side and from the DFDR, which is not unusual when
8 using a model. A model is -- is -- it's the same model
9 that we have since the beginning, so we have not done
10 anything to the model. We have taken the model as is.

11 And the model allows us to have a pretty good match
12 with the DFDR parameter.

13 And to the standards of other incidents
14 analyses and so on, we at this time have a good -- good
15 -- pretty -- pretty good essential matching.

16 CAPT. PITTS: All right, sir. In one of your
17 graphs you had a depiction of an A-300 and showed a
18 balanced pressure on each side of the vertical
19 stabilizer. And you had the plane of symmetry aligned
20 with the fuselage reference line.

21 Are you familiar with the low pressure area
22 generated by the vortex of a wing tip vortice?

23 MR. CHATRENET: When the aircraft encounters
24 a -- the vortices, no, I could not tell you. It -- we
25 -- it will depend on how the aircraft hit any wake

1 vortex. Generally, the aircraft has a tendency to --
2 to flow above the wake vortex. So in this case, if the
3 -- if the aircraft flows above the vortex, we'll have a
4 certain repartition on the aircraft. If the aircraft
5 hits -- and went inside of the core of the vortex, it
6 would be another one. But I cannot -- I cannot
7 illustrate this kind of different behavior.

8 CAPT. PITTS: The aircraft's handling
9 characteristics have not been demonstrated moving
10 tangentially through the core of a wing tip vortex, is
11 that correct?

12 MR. CHATRENET: We have some -- some research
13 analysis which is currently performed in order to
14 characterize the -- the aircraft behavior. But this
15 was not used at this stage. And as I have said, up to
16 now we have a pretty good match of the lateral
17 parameter of the aircraft without taking into account
18 any assumption of lateral wind.

19 CAPT. PITTS: Those lateral winds, would
20 those be straight-line winds, sir? Would they be
21 rotational, such as we might expect to see in a wing
22 tip vortex?

23 MR. CHATRENET: At this stage, at the
24 beginning, they would be pure lateral.

25 CAPT. PITTS: So that would not be the case

1 -- that would not be a good comparison to a wing tip
2 vortex?

3 CHAIRMAN CARMODY: Capt. Pitts, --

4 MR. CHATRENET: It depends.

5 CHAIRMAN CARMODY: -- we are having a witness
6 in the course of the hearing on wake vortex. I think
7 those questions should be addressed to him.

8 CAPT. PITTS: I understand.

9 CHAIRMAN CARMODY: This is not the proper
10 witness.

11 CAPT. PITTS: I -- the concern is, as we talk
12 about flight control design and certification, what
13 consideration in the design and in the robustness of
14 the design has included the possible encounter of a
15 wing tip vortice.

16 MR. CHATRENET: Let me maybe develop a bit.
17 What we are doing is that we first start to add some
18 constant lateral wind. And if we get a good matching,
19 it is sufficient to account of any rolling motion
20 coming from the side roll effect. If after that it is
21 not yet enough to put -- to get a good matching, then
22 we have a pure rolling effect, but we do it
23 progressively.

24 So first, we make an assumption, no wind at
25 all. Is it good, is it valid. If it is sufficiently

1 good, we are happy with that. Then if we try to refine
2 the matching of the model with the -- with the
3 aircraft, we add some lateral wind, pure lateral wind,
4 which anyway includes some rolling effect through the
5 side roll effect. And if it is not yet enough, then we
6 add a pure rolling effect with no lateral acceleration.

7 But we made it -- this in sequence. So we
8 are at the stage where we have nothing at all and we
9 get a pretty good matching already. So what we expect
10 to be necessary to even improve this matching is
11 something very small, very small in lateral, and
12 probably nothing in roll or very small in roll as well.

13 CAPT. PITTS: Okay. So in consideration,
14 sir, of the fidelity of the digital flight data
15 recorder and sampling rate and the difficulties that
16 Mr. Benzon spoke to in the opening of this hearing, how
17 much confidence do you have in the traces and the
18 values that we're presenting here as we try to bring in
19 external forces to match what we think happened?

20 MR. CHATRENET: We have -- we have a pretty
21 good confidence in the -- in the time history of the
22 rudder because we think that this time history is
23 satisfying simultaneously two criteria. The first one
24 is, once it is filtered, it is exactly matching with
25 the DFDR recorded rudder position. And secondly, when

1 it is input into the model, it gives some essential
2 matching with the aircraft response.

3 CAPT. PITTS: What studies of the phenomenon
4 known as adverse aircraft pilot coupling has Airbus
5 conducted in terms of flight control design?

6 MR. CHATRENET: So in terms of flight control
7 design, I think that we -- we -- this topic will be
8 better addressed later on as human factors or
9 operational aspect.

10 But let me say from a handling quality point
11 of view, PIO or APC has an oscillating characteristic
12 with a fixed frequency. That's why at this stage we
13 have no evidence of fixed frequency and servo
14 oscillation with some kind of similarity with APC
15 phenomena or PIA phenomena.

16 CAPT. PITTS: Outside of this investigation,
17 sir, has Airbus included APC into their flight control
18 designs as a design philosophy?

19 MR. CHATRENET: It is --

20 CAPT. PITTS: In dealing with adverse
21 aircraft pilot coupling issues?

22 MR. CHATRENET: It is a part of our, I would
23 say, verifying or -- or, I would say, validation
24 exercise to check that the aircraft are free of any APC
25 tendency.

1 CAPT. PITTS: Back to the objective
2 evaluation, did Airbus use anything along the lines of
3 a Cooper-Harper rating scale to evaluate the aircraft
4 pilot coupling issues and handling characteristics?

5 MR. CHATRENET: No, because we have other
6 alternatives. We have alternatives from -- coming from
7 the GA where you -- where we use mainly the certain 09
8 classification.

9 CAPT. PITTS: So you consider that a suitable
10 substitute for a Cooper-Harper objective analysis?

11 MR. CHATRENET: Exactly.

12 CAPT. PITTS: One last question. It's three
13 parts. Have there ever been any failures of the
14 artificial feel and trim unit centering function on the
15 A-300-B4-605-R?

16 MR. VAN den BOSSCHE: No. No failures have
17 been told of the centering function.

18 (Pause)

19 CAPT. PITTS: I have no further questions,
20 Madam.

21 CHAIRMAN CARMODY: I'll move now to Airbus.
22 Any questions of your witness?

23 DR. LAUBER: Madam Chairman, I did have
24 several questions for this witness, but in view of the
25 hour, I'm going to limit it to one very quick question.

1 CHAIRMAN CARMODY: Thank you.

2 DR. LAUBER: Mr. Ahearn asked you a series of
3 questions, Mr. Chatrenet, regarding various secondary
4 rudder limiting devices, such as blowdown and hydraulic
5 flow restrictors and similar kinds of things. Do you
6 recall that?

7 Can any of those systems be effective against
8 the dynamic build-up of side slip caused by cyclic
9 rudder input that excites the dutch roll
10 characteristics of the air frame?

11 MR. CHATRENET: No, I don't think so. I
12 don't think so. We have shown the chart when we show
13 that the -- the forced oscillation is rapidly growing
14 and then stabilizing. This was obtained with pretty
15 small rudder deflection and cyclic rudder deflection.
16 So this is a basic, I would say, behavior of any type
17 of aircraft if the rudder is actually moving with
18 cyclic deflection even very small, provided that the
19 frequency is matching with the natural frequency of the
20 aircraft. We would get this kind of oscillation with
21 growing amplitude.

22 DR. LAUBER: Thank you, Mr. Chatrenet. No
23 further questions.

24 CHAIRMAN CARMODY: Thank you, Dr. Lauber.

25 We'll now move to the Board members to see

1 any questions they may have.

2 Member Hammerschmidt, any questions from you?

3 MEMBER HAMMERSCHMIDT: Thank you. I just
4 have a quick clarification question. Really, it
5 pertains to something that Mr. Ahearn asked.

6 Mr. Ahearn, your last question, I'm wondering
7 if it derived from a chart that's on page seven of
8 Exhibit 9, Alpha. If you have that handy.

9 (Pause)

10 CAPT. AHEARN: Yes, sir.

11 MEMBER HAMMERSCHMIDT: You weren't too
12 specific about which chart you were referring to, and I
13 just wanted to pin that down.

14 CAPT. AHEARN: Actually, it was a chart that
15 was presented by Mr. Chatrenet during his presentation.

16 But, Mr. Hammerschmidt, it does in fact -- does in
17 fact match the chart that is on this page.

18 MEMBER HAMMERSCHMIDT: Okay. Thank you. I
19 was going to ask the same question that you did, so I
20 just wanted to confirm that.

21 CAPT. AHEARN: Thank you.

22 MEMBER HAMMERSCHMIDT: That's all I have.

23 CHAIRMAN CARMODY: Member Goglia, any
24 questions?

25 MEMBER GOGLIA: I believe -- I believe all my

1 questions have already been asked. Why don't I just go
2 through here quickly so I can --

3 (Pause)

4 MEMBER GOGLIA: I've already -- asked and
5 answered.

6 CHAIRMAN CARMODY: We've had some very
7 thorough questions.

8 Member Black, any questions from you?

9 MEMBER BLACK: Just a brief question. Did --
10 did Airbus do any testing about this change from the
11 B2-B4 over to this new system? Did you look at pilot
12 responses, your internal company pilot responses,
13 controllability differences that they might have
14 perceived between the two systems? I guess I'm talking
15 about human factors testing and changing between the
16 systems.

17 MR. CHATRENET: Formally speaking, I don't
18 think that we have made, I would say, back-to-back
19 comparison between the B2-B4 and the 600-R version.

20 But nevertheless, we have applied during the
21 design process and the certification process of the A-
22 300-600-R the same criteria, the same maneuvers. We
23 have asked for the same type of control accuracy and
24 evaluation that we have done for the B2-B4.

25 So even if there was no back-to-back

1 comparison of the two aircraft, both have been run
2 through the same process of verification and validation
3 of the handling qualities associated with both designs,
4 with both flight control designs.

5 MEMBER BLACK: Thank you, sir.

6 CHAIRMAN CARMODY: And I have no questions of
7 the witnesses, but let me thank Mr. Chatrenet and Mr.
8 Van den Bossche for your time and for your testimony.
9 It's been very helpful, and we appreciate your
10 cooperation.

11 I'd like to now dismiss these witnesses with
12 the understanding you may be called back later.
13 There's always that possibility.

14 (Whereupon, the witnesses were excused.)

15 CHAIRMAN CARMODY: And before we proceed to
16 the third witness, I'd like to have a break. So why
17 don't we come back a little after five? Maybe five
18 after five. Thank you. Thank you.

19 (Brief recess)

20 CHAIRMAN CARMODY: Let me say while people
21 are taking their seats, we're going to start with our
22 third witness, who is Capt. Larry Rockliff.

23 And I want to ask all parties to please in
24 their questioning be direct, concise, and brief, and
25 not ask the same questions repeatedly. I would also

1 ask the same of our staff, the NTSB Technical Panel,
2 that they be -- certainly, we want the information, but
3 let's think about our questions and ask them quickly
4 and move forward.

5 Ms. Ward, would you call the next witness,
6 please?

7 MS. WARD: I call Capt. Larry Rockliff.
8 Please raise your right hand.
9 Whereupon,

10 LARRY ROCKLIFF
11 having been first duly sworn, was called as a witness
12 herein and was examined and testified as follows:

13 MS. WARD: Thank you. Please have a seat.

14 (Pause)

15 MS. WARD: Capt. Rockliff, would you please
16 state your full name, your current employer, and your
17 business address?

18 THE WITNESS: My name is Larry Bruce
19 Rockliff. I am vice president of training for Airbus
20 North America Customer Services. And I work in Miami
21 Springs, address 4355 Northwest 36th Street.

22 MS. WARD: How long have you been in your
23 current position?

24 THE WITNESS: Been in the current position
25 for three years.

1 MS. WARD: And could you briefly describe
2 your duties and responsibilities, including any
3 education and training that you've received, to qualify
4 you for your position?

5 THE WITNESS: My duties and responsibilities
6 are oversight of all training for flight maintenance
7 and cabin crew for North America and to implement the
8 training policies of our parent company in Toulouse.

9 MS. WARD: Could you also list your -- list
10 the FAA aviation certificates that you hold, any flight
11 time that you have, and the aircraft that you've flown?

12 THE WITNESS: Okay. My career started out in
13 the Air Force in Canada. In Canada, I completed tours
14 on trainers, fighters, the Canadian air demonstration
15 team the Snowbirds, and transports.

16 I hold two ATPs, a Canadian and an FAA. And
17 I'm endorsed for check pilot privileges on 20 different
18 regulatory bodies.

19 I'm type rated on A-300, A-310, A-320, A-330,
20 and A-340. I've instructed on each of those aircraft,
21 and I've been involved in, excuse me, development of
22 training programs for all of the Airbus fly-by-wire
23 airplanes.

24 MS. WARD: Thank you. Madam Chairman, I find
25 this witness qualified and now pass it over to Capt.

1 Dave Ivey for questioning.

2 CHAIRMAN CARMODY: Thank you. Capt. Ivey,
3 please continue.

4 TESTIMONY OF CAPT. LARRY ROCKLIFF

5 CAPT. IVEY: Good evening, Capt. Rockliff.
6 I'd like to begin by discussing the Airplane Upset
7 Recovery Training Aid and how that was developed and
8 who actually developed that program?

9 THE WITNESS: The Upset Training Aid -- the
10 Industry Upset Training Aid was the compilation and
11 work of aircraft manufacturers, airlines, unions, and
12 input from the FAA and in fact the NTSB also.

13 CAPT. IVEY: Can you tell me when the
14 development of the Training Aid actually began?

15 THE WITNESS: The kickoff for the Training
16 Aid began in June of 1996.

17 CAPT. IVEY: And what was the motivation
18 behind the development of the Industry Training Aid?

19 THE WITNESS: It was actually in response to
20 initiatives from the NTSB and the FAA in -- with an
21 interest that the NTSB had put forward to further
22 education of flight crew to recognize and recover from
23 upsets.

24 CAPT. IVEY: And it's my understanding that
25 the FAA issued a handbook bulletin called, "The

1 Handbook Bulletin for Air Transportation," the HBAT 95-
2 10. And that's Exhibit 2-E-16, for those that might be
3 interested.

4 Are you familiar with that document?

5 THE WITNESS: Vaguely familiar now. I
6 certainly was back in the mid '90s.

7 CAPT. IVEY: And what was the purpose of that
8 document and how was it generated?

9 THE WITNESS: Well, I think that the purpose
10 of the document was to, again, respond to the NTSB
11 recommendations and to provide guidance to inspectors
12 and for training providers in the form of upset
13 training.

14 CAPT. IVEY: And why did Airbus get involved
15 in the Upset Training Aid development?

16 THE WITNESS: Well, as I mentioned, it was an
17 industry initiative. And as a significant member of
18 the industry, Airbus was partnering with the other
19 manufacturers in the capacity of the manufacturers'
20 input.

21 CAPT. IVEY: And you mentioned the various
22 manufacturers. Were there any other bodies that were
23 involved in the development of this Industry Training
24 Aid?

25 THE WITNESS: I'm not sure I understand what

1 you --

2 CAPT. IVEY: Oh, such as the Airline
3 Transport Association and a collection of the carriers,
4 that sort of thing?

5 THE WITNESS: Yes.

6 CAPT. IVEY: Those bodies?

7 THE WITNESS: Yes. Actually, the kickoff
8 meeting occurred at Air Transport Association
9 headquarters here in Washington, D.C. All three of the
10 manufacturers -- at that time there were three large
11 air framers, McDonnell Douglas, Boeing, and ourselves,
12 Airbus. A large cross section of U.S. carriers as well
13 as Canadian carriers. And as the program evolved,
14 there was actually participation from foreign carriers,
15 Europe and Asia as well. And of course, the -- the
16 unions.

17 CAPT. IVEY: And at the time that this
18 kickoff occurred, were there any airlines that were
19 actually in development or had in place upset maneuver
20 programs or advanced maneuver training?

21 THE WITNESS: There was.

22 CAPT. IVEY: And who might they have been?

23 THE WITNESS: American Airlines, United
24 Airlines, and I believe Delta was in the final stages
25 of developing a program for themselves.

1 CAPT. IVEY: And when this group got together
2 to begin the Industry Training Aid, were the programs
3 that were at that time in place, were they reviewed?

4 THE WITNESS: In part. Yes, there was a
5 review of the programs.

6 CAPT. IVEY: And what was the consensus, if
7 you will, of, say, ATA or the bodies that were
8 collected together to -- upon review of the United
9 program, for example, and the American program. What
10 was their opinion of what had been developed at that
11 point?

12 THE WITNESS: Well, first of all, there are
13 two points to answer that question. First is that in
14 reviewing them with inputs from the collective group,
15 there was recognition that there were some positive
16 points, actually common points between all of the
17 programs that existed. There were other points that
18 were unique to particular carriers.

19 In the interest of -- of maintaining a fairly
20 standard training package for the industry in the form
21 of training aids, the decision was made at that time
22 not to adopt any of the individual ones that existed
23 because none of them were optimized to a particular
24 industry training aid.

25 And so the goal was to continue in the -- in

1 the spirit of the previous successful training
2 products, such as controlled flight into terrain --
3 takeoff safety training aid, wake turbulence training
4 aid. So this was a logical evolution.

5 CAPT. IVEY: And as the program became
6 established, were there significant differences that
7 were -- among the industry participants as to how this
8 should be approached?

9 THE WITNESS: There was. Many of the
10 carriers, certainly the ones who had already
11 established programs, for all good reasons were trying
12 to look for a product that would serve all of their
13 fleets with a simplistic kind of approach and to
14 proceduralize it.

15 The manufacturers, all three, were very
16 consistent in our concerns for that kind of approach.
17 We felt that upset training was more of an awareness
18 training because the infinite number of variables that
19 could be experienced versus distilling it into
20 something very simple in the form of one-size-fits-all
21 for recovery.

22 CAPT. IVEY: And so there was never
23 consideration given to adopting something that had
24 already been planned out? As an example, American's
25 Advance Maneuvers Program or United's Upset Training

1 Program?

2 THE WITNESS: The point was raised, and it
3 was rejected at the first meeting.

4 CAPT. IVEY: And why was it rejected?

5 THE WITNESS: Well, for the reasons that I
6 had mentioned so far. There were -- there were good
7 points, and definitely, good points that were contained
8 in the programs that already existed would be applied.
9 But there were also other points that were of concern
10 to -- to some of the people, specifically Airbus and
11 Boeing and McDonnell Douglas.

12 CAPT. IVEY: Can you enumerate on some of the
13 points of difference?

14 THE WITNESS: Well, specifically, with the
15 American Airlines product, the -- what appeared to be
16 the emphasis on rudder at that time was a concern to
17 manufacturers.

18 CAPT. IVEY: Any other areas of concern?

19 THE WITNESS: The utilization of simulation.
20 There was a fair amount of discussion on automation,
21 automation dependency. And those were pretty much the
22 areas that -- that we focused on.

23 CAPT. IVEY: And you mentioned simulation.
24 How did Airbus come down on the issue of simulators?
25 For or against?

1 THE WITNESS: Well, at that time -- this was
2 very early in the program. And I think that even the
3 carriers were just in the infancy stage of it.

4 Airbus's position on that -- on the use of
5 simulators at that time was we were not in favor of
6 using simulators for upset recovery training.

7 CAPT. IVEY: And from the time that the
8 industry group formed until the Industry Training Aid
9 was developed, how long a time period was that?

10 THE WITNESS: The first meeting was in June
11 1996, and the package, which was distributed jointly
12 between -- to all of the operators of the world, was
13 produced in August of '98. Boeing and Airbus and
14 Flight Safety Foundation distributed it to all of the
15 operators.

16 CAPT. IVEY: And once the Industry Training
17 Aid was developed and handed to all the operators
18 around the world, were there differences that still
19 remained among the participants?

20 THE WITNESS: The purpose of the Training Aid
21 was, as I had mentioned a moment ago, not too
22 proceduralized. And so because there was a lot of
23 consensus that had to go on with any package that's
24 done with a large cross section of -- of participants,
25 the choice of how to utilize specifics of the package

1 was left up to the carriers. So, by definition, there
2 would be differences.

3 Airbus and Boeing were able to identify the
4 specifics of the awareness that we were trying to put
5 out and had tried to convey to the operators throughout
6 the development phase in the form of our Technical
7 Digest which came out earlier in 1998.

8 CAPT. IVEY: And once the Industry Training
9 Aid was developed and handed out in 1998, have there
10 been any changes to the Industry Training Aid since
11 that time?

12 THE WITNESS: There is actually a change
13 that's in process right now. And it's in fact in
14 response to another recommendation of the NTSB and the
15 FAA subsequent to -- to this investigation.

16 CAPT. IVEY: And could you enlighten us as to
17 what that is?

18 THE WITNESS: Well, as Mr. Benzon mentioned
19 this morning, the two recommendations that were -- were
20 forwarded in February requested or required that the
21 manufacturers were to identify some knowledge points
22 and some education. So line by line, the
23 recommendations of the NTSB and the FAA are being
24 responded to both in the form of -- of other manuals,
25 but in particular, the Upset Training Aid.

1 CAPT. IVEY: And you mentioned that during
2 the development of the Industry Training Aid, Airbus
3 was against the use of simulators for teaching advanced
4 maneuvers. Could you explain to me why, specifically?

5 THE WITNESS: Well, first of all, the use of
6 a simulator has some tremendous deficiencies or
7 limitations for unusual, out-of-the-ordinary type
8 flying. It was touched on a little bit earlier today,
9 but specifically, the forces that a pilot would
10 experience in terms of increased weight or G-loading,
11 as we know of it, both vertically and laterally. These
12 cannot be duplicated in a simulator, so those were
13 concerns.

14 In addition, the actual fidelity -- the
15 actual information that goes into providing the
16 simulation, the actual copy of the airplane, is in a
17 relatively narrow band as compared to what a -- an
18 aggressive upset could actually cause upon a pilot.

19 So it was for those reasons specifically, but
20 more importantly, it also came down to the fact that in
21 simulators, the tendency is that training is procedure-
22 based. And as I mentioned a moment ago, our emphasis
23 was on awareness training and not procedure training,
24 from the manufacturers' point of view.

25 CAPT. IVEY: And is one of the reasons that

1 you were opposed to the simulation due in fact to
2 earlier testimony that talked about the envelope
3 protection in the fly-by-wire airplanes? Although the
4 A-300 is not fly-by-wire, but was that part of the
5 motivation for not being interested in the use of
6 simulators?

7 THE WITNESS: Not at all. We were quite
8 specific, as was the other manufacturer, that insofar
9 as fly-by-wire aircraft, by definition, unintentional
10 exceedance of certain parameters is what defines upsets
11 and that fly-by-wire airplanes wouldn't normally end up
12 in those situations. But we both -- in our case, for
13 our response, we produce A-310, A-300 aircraft, and we
14 still have A-300-B4 aircraft out there.

15 So that decision was on the basis of the
16 conventional flight control systems and the -- and the
17 likelihood of the possibility for negative training if
18 it's -- if it's used improperly in the simulator
19 environment.

20 CAPT. IVEY: If in fact simulators were to be
21 used in your advanced aircraft, your fly-by-wire, would
22 it require modification in order for the simulators to
23 introduce upset maneuvers or advanced maneuver
24 training?

25 THE WITNESS: It would -- it would require a

1 degradation of flight control laws because of the --
2 the specifics of the fly-by-wire platform that we've
3 got. The airplane will resist upset. And so we'd have
4 to artificially degrade systems in order to get the
5 airplane into those conditions.

6 CAPT. IVEY: We've had earlier testimony
7 about envelope protection, if that's an appropriate
8 term, on your advanced aircraft and the fly-by-wire.
9 Is there an envelope protection in the A-300-600-R?

10 THE WITNESS: Not in the form of a fly-by-
11 wire. There are certain cues that are available to the
12 pilots in the form of -- of alpha trim, you know, angle
13 of attack trim, and things of that nature, just as
14 there is in a lot of other aircraft. You have stick
15 shaker and things of that sort which gives you
16 indication when you're approaching the edges of
17 envelope in one direction or another.

18 But protection in the form of fly-by-wire,
19 no.

20 CAPT. IVEY: And in your fly-by-wire
21 airplanes, there is an envelope protection that's built
22 into the design of the aircraft, is that correct?

23 THE WITNESS: That's correct.

24 CAPT. IVEY: Does that include the rudder or
25 yaw system?

1 THE WITNESS: Specifically, the envelope
2 protection is not considered in yaw. But as the
3 previous testimony indicated, there are certain
4 properties of the roll mode that would imply a feature
5 that would -- that would augment yaw in that the
6 airplane would not tend to roll. It would just -- it
7 would just skid with the introduction of rudder.

8 So although it's not a specific protection,
9 it is much more a stable platform than a conventional
10 flight control system.

11 CAPT. IVEY: Turning for the moment to
12 training, and in particular, I'd like for you to tell
13 me what methods of teaching Airbus uses to train upset
14 recoveries to pilots at your facilities in Miami?

15 THE WITNESS: In Miami, during the ground
16 school phase, we present to all trainees who go through
17 on transition training the upset training video, the
18 industry upset training video. We do not have
19 simulator exercises.

20 CAPT. IVEY: Is there any computer-based
21 training that's associated over and beyond the video
22 itself?

23 THE WITNESS: For upset recovery?

24 CAPT. IVEY: Yes, sir.

25 THE WITNESS: No.

1 CAPT. IVEY: And --

2 THE WITNESS: That is, at this time. It's in
3 development, again, in response to the NTSB and FAA
4 recommendations earlier this year.

5 CAPT. IVEY: And could you tell me what type
6 of training is provided for upset recoveries in
7 Toulouse on your advanced airplanes?

8 THE WITNESS: Can you explain "advanced
9 airplanes"?

10 CAPT. IVEY: Well, I -- the A-310. I realize
11 that the A-300 is not -- there's not a school -- it's
12 my understanding there's not a school that's in
13 Toulouse for the A-300, is that correct?

14 THE WITNESS: In -- in Toulouse, yes. We
15 teach A-310 and A-300 in Toulouse. And --

16 CAPT. IVEY: And so the training is the same
17 there as it is in Miami?

18 THE WITNESS: That's correct.

19 CAPT. IVEY: In terms of the flight crew
20 operating manual, the FCOM as it's called, is there any
21 methods for recovery that are incorporated in the FCOM
22 for pilots to observe and read?

23 THE WITNESS: For upset recovery?

24 CAPT. IVEY: Yes, sir.

25 THE WITNESS: There is now, yes.

1 CAPT. IVEY: And how long has it been in
2 there?

3 THE WITNESS: I believe it went in with a
4 temporary bulletin earlier this year. And -- and if
5 there's been a revision subsequent to that temporary
6 bulletin, it would be included with that. And again,
7 that was in response to NTSB recommendations.

8 CAPT. IVEY: And can you -- are you familiar
9 with the steps in general as to what was inserted in
10 the FCOM?

11 THE WITNESS: I'd have to -- I'd have to look
12 at it again. We don't teach the A-300 in Miami at this
13 time, so my -- my referral to that airplane would have
14 to be by looking at an exhibit, if it's in there.

15 CAPT. IVEY: In terms of A-300 training,
16 which major Part 121 carriers in the United States
17 operate A-300s and have taken Airbus training?

18 THE WITNESS: American Airlines, Fed Ex, and
19 UPS. American -- originally, when they received the
20 airplanes back in the late 1980s, the initial cadre
21 group of pilots were trained by Airbus, the very
22 initial group.

23 The same was the case with Fed Ex. And
24 actually, only one crew with UPS. UPS actually had
25 some -- some folks train at Fed Ex for their initial --

1 initial cadre airmen.

2 CAPT. IVEY: And you -- you mentioned
3 "initial cadre." Since that initial training, has any
4 of those carriers been back to use Airbus training?

5 THE WITNESS: For wet training where our
6 instructors conduct it?

7 CAPT. IVEY: Yes, sir.

8 THE WITNESS: To my knowledge, no. Certainly
9 not in -- in Miami. I cannot speak for Toulouse.

10 CAPT. IVEY: Do you have any idea as to why
11 they've not used your training?

12 THE WITNESS: Well, in the case of American
13 Airlines and Fed Ex, they both had their own
14 simulators. So it's fairly normal, quite usual, for
15 Part 121 carriers to have the initial cadre go to the
16 manufacturer, usually the project pilots. From that,
17 they develop their own training programs, utilize their
18 own resources.

19 Now, if there is a case where they haven't
20 yet received their simulators, they may come and use
21 the manufacturer's simulator, but for the most part, it
22 would be what we call "dry training," where they use
23 their instructors, their -- their check airmen, and
24 simply use their equipment.

25 CAPT. IVEY: Has there been any discussions

1 between Fed Ex, UPS, or American regarding differences
2 in their approach to training? And let's focus
3 specifically on upset training compared to what Airbus
4 offers.

5 THE WITNESS: Nothing has been brought to my
6 attention.

7 CAPT. IVEY: And what about the rest of the
8 world? Does the foreign carriers use Airbus for their
9 training?

10 THE WITNESS: Some do. Our -- our resources
11 and our capacity is normally set up for entry into
12 service of new aircraft. As you can imagine, carriers,
13 as they receive more and more airplanes, have
14 traditionally transitioned into conducting their own
15 training.

16 So the usual is that foreign -- foreign
17 carriers at least, we'd end up doing more than the
18 initial cadre, but we wouldn't conduct the wet training
19 for them indefinitely.

20 CAPT. IVEY: Is there a difference in
21 philosophy towards upset maneuver training between
22 Airbus and American? And has it been discussed between
23 the two of you?

24 THE WITNESS: Yes.

25 CAPT. IVEY: Could you explain to me what

1 those differences and the discussions were focused on?

2 THE WITNESS: Well, specifically, use of
3 rudder is -- is a difference between what Airbus
4 considers as a method for normal roll control than what
5 American has supported in their AAMP program.

6 CAPT. IVEY: Has that been the major sticking
7 point?

8 THE WITNESS: It's been an ongoing point
9 since the end of 1995.

10 CAPT. IVEY: Turning for a moment to the
11 AAMP, A-A-M-P, or the Advanced Aircraft Maneuvering
12 Program, that American uses, did Airbus get involved in
13 the development of that program initially?

14 THE WITNESS: No. We weren't invited to,
15 although I was invited to observe it after it was
16 complete. But insofar as the development, no.

17 CAPT. IVEY: Were any other manufacturers
18 invited or any other members of industry and aviation
19 invited to help in their development?

20 THE WITNESS: Well, only through testimony
21 I'm told that -- that they were, but I don't know that
22 firsthand from talking with other manufacturers.

23 CAPT. IVEY: And so the first real
24 participation for Airbus in the Advanced Aircraft
25 Maneuvering Program was at the conference where

1 industry was invited to attend?

2 THE WITNESS: No, it was before that. I was
3 invited by the -- the vice president of flight
4 operations at that time to come and observe their AAMP
5 program in the autumn of 1995, which was fairly early
6 in the program. I believe they were just exposing
7 their check airmen and instructors at that time.

8 CAPT. IVEY: There was an Airbus Industries
9 presentation concerning Airplane Upset Recovery
10 Training Aid at the 10th Performance and Operations
11 Conference, and that was held in San Francisco,
12 California, in September 28th through the 2nd of
13 October in 1998, I believe.

14 THE WITNESS: That's correct.

15 CAPT. IVEY: Did you participate in that?

16 THE WITNESS: I did.

17 CAPT. IVEY: And did you participate in the
18 presentation that was made there?

19 THE WITNESS: During the Q & A at the end of
20 it, yes.

21 CAPT. IVEY: And just for clarification,
22 that's Exhibit 2-F, those of you that have the
23 exhibits.

24 And would you please describe the purpose of
25 that presentation?

1 THE WITNESS: Our chief test pilot, Capt.
2 Bill Wainwright, chose to -- to write a paper out of
3 interest for all the operators because this Ops
4 Performance Conference is -- is an invitation to all of
5 the global Airbus operators in all of our aircraft.
6 And so he chose to identify the evolution of the
7 program and how the flight test pilots from the three
8 manufacturers became involved.

9 CAPT. IVEY: And there are several items
10 listed in that that really talk about the differences
11 of opinion. And there seemed to be a conflict between
12 the technical advice that was being given by the
13 manufacturers and the operators with regard to training
14 of pilots in the simulators. Can you tell me basically
15 what the crux of that matter was and the differences?

16 THE WITNESS: Are you referring to a specific
17 spot in his presentation that you'd like me to speak
18 to?

19 CAPT. IVEY: If you could turn to Exhibit 2-
20 F, page three?

21 (Pause)

22 THE WITNESS: Yes?

23 CAPT. IVEY: And in the first paragraph up
24 there, right from the beginning there was a conflict
25 between the technical advice given by the

1 manufacturer's training pilots --

2 THE WITNESS: Mm-hmm.

3 CAPT. IVEY: -- and that expressed by those
4 of the principal airlines already practicing upset
5 training. Could you help me understand what this
6 conflict was really about?

7 THE WITNESS: Well, I don't know that
8 "conflict" -- it's a fairly harsh term. But for sure,
9 there were differences of how best to approach the
10 issue. In our case, the training representatives from
11 the manufacturers, myself representing our Development
12 Department in Toulouse and a counterpart from Boeing
13 representing that company, we were trying to
14 deemphasize the emphasis on rudder as a -- as a roll
15 control in upset recovery. And we weren't having a
16 great deal of -- of success in convincing our
17 counterparts, the training people in the carriers.

18 So for that purpose, we requested that our --
19 that our troop, people who have been in that region
20 that the test pilots who actually operate closer to the
21 edge of the envelope, we asked them to come and -- and
22 help out with their technical input.

23 There were other areas, but in particular, it
24 was -- it was use of rudder.

25 CAPT. IVEY: And I think also the use of

1 simulators was featured in that presentation also, is
2 that correct?

3 THE WITNESS: Mm-hmm. Yeah.

4 CAPT. IVEY: Again, on that page, it said
5 that "The conflict remained until we finally achieved
6 an agreement at the last meeting in January of 1998."
7 That's right at the end of the second paragraph.

8 THE WITNESS: Mm-hmm.

9 CAPT. IVEY: So it took a while to get these
10 differences ironed out. Can you explain to me how the
11 operators were having such a difference of opinion
12 between the use of rudder and the use of simulators as
13 two of the differences? Why did it take so long?

14 THE WITNESS: I believe that probably the
15 operators were quite convinced that the conclusions
16 that they'd come to were valid. And it was a case of
17 trying to convince them from the technical expertise
18 from the -- from the manufacturers that -- that their
19 conclusions were not valid for some of their -- some
20 aspects of their training packages.

21 CAPT. IVEY: And you actually go on to say in
22 the article that the difference -- of opinion between
23 the three test pilots in the group, there wasn't any.
24 There was never a difference. And so you have three
25 manufacturing test pilots that are in agreement and yet

1 the operators are resisting this approach to the
2 Industry Training Aid. Is that a factual statement?

3 THE WITNESS: Not to the Training Aid but to
4 certain components of the Training Aid.

5 CAPT. IVEY: Yes. I stand corrected.

6 THE WITNESS: Yes.

7 CAPT. IVEY: Yes. In particular, the use of
8 rudder and use of simulators. Was the Training Aid
9 designed to be a supplement to simulator training?

10 THE WITNESS: A supplement to simulator
11 training? No. The Training Aid was intended to be a
12 stand-alone package, just as previous training aids had
13 been. And it was, as I mentioned earlier, in the very
14 same spirit as -- as previous training aids.

15 Given that it was a tool or a product for the
16 entire aviation community, a lot of carriers in other
17 parts of the world wouldn't have the resources that a
18 lot of our carriers have over here so that some of them
19 would use it as -- as only the video, some of them only
20 the workbook, some of them only the CDs, and some of
21 they may have in fact also used them to develop
22 simulator training programs.

23 CAPT. IVEY: And in earlier testimony, you
24 stated that the use of simulators for upset training
25 was not Airbus's opinion in which that should be used?

1 THE WITNESS: Yes. I think it's important to
2 note that, again, this is a industry product and so
3 that people will utilize it for exactly that. They'll
4 -- they'll either use it for its total capability or
5 partially, dependent on what their particular needs are
6 or what they decide their needs are.

7 And from the Airbus point of view, we had
8 those concerns. We still have those concerns about the
9 use of simulator due to the high possibility of
10 negative training if it's not conducted properly.

11 CAPT. IVEY: If simulators can't be modeled
12 for unusual attitudes, should they be used at all in
13 upset recovery training?

14 THE WITNESS: If the -- if a program is
15 properly tuned and it is -- and it is kept -- the
16 instructors are properly qualified and -- and
17 parameters are tightly maintained so that -- so that
18 the data that the trainee -- that the crew under
19 training receives is valid, then -- then there may be
20 some value to it.

21 However, there is a lot of risk. And so if
22 you put it on balance and we consider the fact that
23 it's an awareness education and not a procedure-based
24 initiative, then there are probably other tools that
25 are more appropriate than simulators.

1 The adage that -- one thing in our business
2 of training that we've become fairly comfortable with
3 throughout the years is that we can always bump up the
4 level of training that we use. And at certain points
5 we don't want to bump it any further. We stop at a
6 simulator because it wouldn't be safe to go to an
7 airplane.

8 But there's also other areas where it's
9 equally practical to bump down in the level of -- of
10 training device or training media that you use. And at
11 Airbus, we feel that upset training is -- upset
12 awareness training is definitely an area where that
13 needs to be looked at.

14 CAPT. IVEY: So if airplanes are dangerous to
15 actually perform the maneuvers and simulator modeling
16 is inaccurate, then how does a pilot learn the basic
17 skills so that they'll revert to what's being taught
18 either procedurally or, as you say, awareness?

19 THE WITNESS: One area that the entire
20 industry -- that there was total consensus on is that
21 by the time a pilot is operating an airplane for a
22 major carrier, a large airplane, they should have had
23 some sort of basic training in unusual attitude
24 recognition and recovery. At a certain point through
25 primary flight training and as they work through their

1 licenses, they are continuing to qualify to become a
2 pilot. And there are certain components, there are
3 certain pieces of becoming a pilot that are just part
4 of that education, like in any other profession.

5 Once you're already in the profession and
6 simply transferring or transitioning from one aircraft
7 type to the next, it's very, very late to be teaching
8 basic skills that were missed.

9 So there was unanimous agreement in that
10 field that the proper place for this education is very
11 early in a pilot's career. Then, afterwards, an
12 academic computer-based training module, some sort of
13 supplement to it, a refresher, would be much more
14 appropriate than -- than primary skills when a person
15 is already well established in their career path.

16 CAPT. IVEY: Turning to the simulators for a
17 moment, has it been your experience that in the process
18 of upset maneuver training that's being developed, is
19 the aspect of stalling being ignored, or going past the
20 stick shaker, in part of this program?

21 THE WITNESS: During the training itself?

22 CAPT. IVEY: Yes, sir.

23 THE WITNESS: Well, the -- the test pilots
24 raised some -- some very important considerations with
25 reference to upset recovery. And that is, the

1 recognition of when an airplane actually is stalled
2 because within most regulatory bodies, demonstration
3 practices for -- for a stall, the pilots show their
4 competency in recovering from an approach to stall and
5 not a stall condition whatsoever, and they're vastly
6 different.

7 The consequence of an airplane being stalled,
8 when it's stalled, it's out of control but it can get
9 back in control. And that has to be done first before
10 recovery is articulated. Insofar as how operators
11 employ that within their -- in their training programs,
12 I have no -- I have no visibility on that.

13 CAPT. IVEY: Since the accident, are you
14 aware of any modifications in training at Airbus or any
15 of the other airlines that produce upset maneuver
16 training?

17 THE WITNESS: Modifications in training?

18 CAPT. IVEY: Yes, sir.

19 THE WITNESS: Well, definitely in response to
20 the recommendations of the NTSB. We're implementing
21 education and -- and actually simulator training, not
22 in upset recovery but in recognition and response to
23 NTSB recommendations. And I'm not aware of what other
24 carriers or manufacturers are doing.

25 I also note that the Aircraft Upset Training

1 Aid is jointly, with Boeing and ourselves launching it,
2 addressing all of the items that the NTSB has
3 recommended as well. And that will evolve over the
4 next few months to include industry and the -- and the
5 FAA as well.

6 CAPT. IVEY: You have participated in a
7 simulator program involving upsets at American, is that
8 correct?

9 THE WITNESS: That's correct.

10 CAPT. IVEY: And what was your view of the
11 modeling of the simulator? Did it stay within the
12 manufacturer's flight test data, in your opinion?

13 THE WITNESS: Well, I went in with the chief
14 test pilot of McDonnell Douglas on the morning after a
15 AAMP seminar or conference in Dulles. And we had a
16 briefing on some modification work that had been done
17 on the simulator, and so we were taken in the simulator
18 to actually go through a demonstration of -- of how the
19 -- the maneuver unfolded. So -- and that was in an MD-
20 11 simulator.

21 CAPT. IVEY: And what was your view of the
22 maneuver that you encountered?

23 THE WITNESS: It was a wake vortex or a
24 simulated wake vortex maneuver. We had been briefed at
25 that time that the evolution -- how the instructor

1 would set the maneuver up would be to select some kind
2 of a selection at the instructor's station and it would
3 cause a little bit of a burble in one direction or
4 another, followed by a fairly rapid -- very rapid roll
5 to the opposite direction, and that in order to
6 facilitate this particular input to the controls, the
7 roll -- the roll surfaces were either partially or
8 completely inhibited so that the airplane would develop
9 a fairly high roll rate. And if the pilot didn't
10 respond to it, they would end up with a significant
11 attitude problem. You know, they'd be upside down.

12 CAPT. IVEY: And you mentioned the roll
13 inhibition. Did it appear that the rudder was
14 inhibited, too?

15 THE WITNESS: At that time, my recollection
16 is it absolutely wasn't. As a matter of fact, the
17 chief test pilot for McDonnell Douglas at that time
18 suggested that since we knew that the roll surfaces had
19 been partially or completely inhibited, we would simply
20 use rudder to try and control the -- the roll moment,
21 which he did. And we were able to work our way through
22 it.

23 CAPT. IVEY: And just to clarify an earlier
24 witness's statement, Mr. Chatrenet, there was a comment
25 made that in cruise that normally the rudder is not

1 used and roll is controlled by aileron. Could you as a
2 pilot talk about how aileron and rudder are used to
3 control an airplane?

4 THE WITNESS: Yes, I can. I think that we
5 need to be clear and -- well, we need to be clear that
6 aileron and normal roll control is -- is through
7 ailerons and roll spoilers conducted through the yoke
8 or in the side stick, depending on the type of
9 airplane. And rudder is not a primary flight control
10 to induce roll under any circumstance unless normal
11 roll control is not functional.

12 So the consequence of that is that the
13 ailerons, whether you're in cruise or whether you're
14 elsewhere in the flight envelope, at a much slower or
15 higher angle of attack, ailerons and roll spoilers
16 would continue to be your normal, usual roll control.

17 Rudder, on the other hand, is used to control
18 the yaw. It's -- it's used to zero side slip. Mr.
19 Chatrenet spoke to it, I think, quite well, that for
20 thrust asymmetry or drag asymmetry, whatever the cause,
21 if you have a yaw condition or a side slip condition,
22 the rudder is dimensioned and it is there to zero it
23 out, for the pilot to apply rudder so that you end up
24 with this zero or reduced loading. And that's
25 throughout the entire envelope.

1 CAPT. IVEY: You'd mentioned earlier that one
2 of the limitations of the simulator is the fact that a
3 pilot in training cannot feel the lateral Gs or even
4 the excess positive Gs, or negative Gs for that matter,
5 in a simulator.

6 THE WITNESS: That's correct.

7 CAPT. IVEY: Do you believe that given the
8 state of a simulator in the development that we're at
9 at this point in time, with a level C in the case of
10 American's A-300 simulator, that a half a loaf is
11 better than no loaf at all? And that is to say that
12 although a pilot can't experience all the G forces
13 either in the pitch roll or yaw axis that they may be
14 able to develop a means to recognize and to recover
15 from upset maneuvers as opposed to sitting in a room
16 such as this listening to a lecturer or interacting
17 with a computer-based training device or a video tape.
18 Do you think that a half a loaf is better than no loaf
19 at all?

20 THE WITNESS: It's a -- it's a long question,
21 and I'll try and keep the answer fairly concise. The
22 half a loaf would be acceptable if it hadn't gone bad.
23 That means that if it's -- if you're going to eat
24 something that's going to make you sick, or in other
25 words, if you're going to train something which is

1 going to cause negative training, then I would not
2 agree with that statement.

3 However, if it was edible, in other words,
4 you were in the envelope of the airplane, the -- you
5 could confirm and validate the fact that the training
6 that you were trying to conduct was sound training and
7 you were going to have a positive transfer of
8 information to the trainee, then, yes, it could be. It
9 could be positive.

10 However, there's -- there's a wide swath
11 being not able to eat your half loaf and -- and having
12 it acceptable. And so I think that in order to avoid
13 that risk, we'd be better off dropping down a level.

14 CAPT. IVEY: In your opinion, when the AAMP
15 Program was first started by American Airlines, do you
16 believe that it was teaching excess rudder usage?

17 THE WITNESS: I do.

18 CAPT. IVEY: And in what areas were they
19 emphasizing rudder too much?

20 THE WITNESS: Generally, the conditions that
21 I had been exposed to in the presentation and with the
22 ongoing evolution of the Upset Training Aid. I need to
23 note that the author or the developer of the AAMP
24 program was also a participant with the Industry Upset
25 Training Aid. So it wasn't a snapshot. Only when I

1 saw the program in the autumn of '95.

2 At that time, there was a considerable amount
3 of emphasis -- or at least, I felt there was a
4 considerable amount of emphasis on the use of rudder to
5 induce roll at high angles of attack. And the
6 conclusion and the validity of their -- the conclusion
7 was that apparently, as validated in the simulators,
8 the roll control of the airplane or the simulator was
9 significantly stagnated or reduced. And so that the
10 conclusion or the discovery was that the rudder was
11 quite effective.

12 CAPT. IVEY: And so that was leading to a
13 negative training? Would that be a fair --

14 THE WITNESS: Well, again, I come back to the
15 basic premise. Rudder is not a flight control, a
16 primary flight control, for inducing roll. It is there
17 if the roll is not properly working.

18 Perhaps more to the point would have been to
19 discover why the roll control wasn't working and if in
20 fact it was because the airplane was at an exceedingly
21 high angle of attack that perhaps reducing the angle of
22 attack might have been the proper solution versus using
23 a flight control that the pilot had never been exposed
24 to before as a roll flight control and concluding that
25 to be a solution.

1 CAPT. IVEY: And since the time in which you
2 visited the AAMP program, has American made changes to
3 the emphasis on rudder?

4 THE WITNESS: Well, there was -- we were
5 told, "we" being Boeing and McDonnell Douglas and
6 ourselves, that the company had -- had determined that
7 use of coordinated rudder was appropriate and that just
8 excessive rudder was not. So yes, that was something
9 that American Airlines had conveyed.

10 CAPT. IVEY: In your opinion, is American
11 Airlines' emphasis on training more to the recovery of
12 an upset as opposed to recognizing the entry or the
13 approach to an upset?

14 THE WITNESS: It's going back quite a long
15 ways to -- to when I sat in on the -- on the
16 presentation. And at this time I just can't remember
17 clearly as to whether there was a great deal of
18 emphasis on -- on recognition and avoidance versus
19 recovery. Definitely, recovery was mentioned, but I
20 can't speak to whether or not there was modules towards
21 recognition and avoidance.

22 CAPT. IVEY: Based on when you went through
23 the simulator, and that was early, I understand, do you
24 believe that if that program had remained as it was
25 then that American Airlines' pilots would have been

1 conditioned to use rudder more than had they not
2 emphasized rudder in the early stages?

3 THE WITNESS: I do. That which we
4 experienced is not unlike what any pilot would do with
5 any airplane regardless of type, regardless of place.
6 If they're experiencing a roll for whatever reason,
7 they will intuitively try and counter the roll with
8 their normal roll control. If they exhaust their
9 normal roll control, they will then go to rudder to try
10 and -- to try and induce a roll.

11 And so, if in fact they are to experience
12 something of that nature in the simulator, then they
13 would be -- that is to say, that which the chief test
14 pilot for McDonnell Douglas and I experienced -- they
15 would find themselves in each iteration finding
16 themselves using rudder to -- to arrest the roll rate
17 and eventually start the recovery. That would be, in
18 my opinion, negative conditioning.

19 CAPT. IVEY: And you mentioned just a few
20 moments ago, which leads to my question, and that is,
21 what does the term "coordinated rudder" mean to you?

22 THE WITNESS: To me?

23 CAPT. IVEY: Yes.

24 THE WITNESS: To me, coordinated rudder is
25 zero side slip. Essentially, it's keeping the ball in

1 the middle.

2 CAPT. IVEY: And in the case of the A-300, is
3 there a ball?

4 THE WITNESS: There's not a traditional ball.
5 There's a small trapezoid on the bottom portion of the
6 sky pointer, an index on the top of the attitude
7 indicator. And that particular index will move from
8 side to side dependent upon side slip forces.

9 CAPT. IVEY: Works the same fashion as a
10 ball?

11 THE WITNESS: Very same fashion. If the ball
12 or if the trapezoid is in the middle, you have
13 coordinated rudder.

14 CAPT. IVEY: And those two indications, the
15 ball in airplanes -- even general aviation airplanes
16 have balls -- and the trapezoid, what does that
17 measure?

18 THE WITNESS: Side slip force on -- on the --
19 on our presentation, on the A-300.

20 CAPT. IVEY: And that would translate to a
21 lateral G for a pilot?

22 THE WITNESS: Correct.

23 CAPT. IVEY: On his body. Do you think the
24 term "coordinated rudder" is well understood by the
25 pilot community at large? And I'm talking about

1 airline pilot community.

2 THE WITNESS: I believe it is. When pilots
3 are in the early phases of their careers, learning how
4 to fly, in particular on -- on small airplane or even
5 some -- some military trainers, they become quite used
6 to keeping the ball in the middle. And as they
7 transition up to the larger aircraft that have turn
8 coordinators and yaw dampers, they also become
9 accustomed to the fact that it's -- it's a fairly
10 automatic process in those airplanes. Certainly on the
11 A-300-600.

12 CAPT. IVEY: What type of rudder usage is
13 taught at Airbus?

14 THE WITNESS: Proper use of rudder?

15 CAPT. IVEY: Yes, sir.

16 THE WITNESS: Well, that's what type of
17 rudder is taught at Airbus. That is -- that is -- it's
18 used for, obviously, the control check and the pilots
19 are exposed to that. It's -- it's used for stressed
20 asymmetry or drag asymmetry. Certainly, in the
21 transition course there's a lot of practice that pilots
22 going through courses would be exposed to in terms of
23 thrust asymmetry. And cross wind takeoffs and
24 landings.

25 In the abnormal phase for system anomalies,

1 which is a normal part of transition on any airplanes,
2 pilots would be exposed to that as well for -- for use
3 of rudder. It is not taught as a roll control.

4 CAPT. IVEY: Is there ever a time that a
5 pilot is instructed to use full rudder for any
6 particular normal or abnormal condition?

7 THE WITNESS: If full rudder is required for
8 a drag asymmetry or a thrust asymmetry. The pilot is
9 taught to use sufficient rudder. They're not taught to
10 use a given deflection. We've talked a lot about
11 numbers and harmonies and things of that sort
12 throughout the day. The truest harmony in the cockpit
13 is between the man and the machine, and that begins the
14 first day they transition on an airplane and it grows
15 and it improves every day after that. And so
16 sufficient rudder is to get the ball back in the
17 middle.

18 CAPT. IVEY: And typically in the training
19 program that Airbus teaches, is there ever a time where
20 pilots are trained to use rudder at higher speeds? And
21 let's use, for example, 250 knots.

22 THE WITNESS: Well, if there was a thrust
23 asymmetry, sure. During the transition the usual case
24 of -- of engine failure practice, engine failure
25 demonstration is during the takeoff just after the

1 refusal speed and just prior to the rotation speed.
2 But the exercise doesn't conclude there. The pilot
3 would then accelerate on through to the final takeoff
4 speed. And dependent upon the training weights or the
5 scenario that was -- that was going on at that time,
6 they would likely end up in the area of 230, 240 knots.

7 CAPT. IVEY: And since the accident, has
8 Airbus made any changes to their airplane flight
9 manuals or to the FCOM regarding rudder usage?

10 THE WITNESS: Yes. Again, in response to
11 NTSB and FAA recommendations, we -- we completed a
12 Flight Crew Operating Manual bulletin in February of
13 this year and -- and then with the subsequent revision.

14 CAPT. IVEY: Exhibit 2-N-6 in the FCOM under
15 the "Abnormal Procedures for Landing Gear Unsafe
16 Indication," part of the procedure was to be to
17 accelerate to Vmax and perform alternating side slips
18 in an attempt to lock the gear. Were you aware of that
19 procedure?

20 THE WITNESS: I was. Or am.

21 CAPT. IVEY: And could you explain the term
22 "Vmax"?

23 THE WITNESS: Vmax is the speed that we have
24 identified on our airplanes that have got electronic
25 flight instrument systems. And it is the maximum speed

1 -- the max limiting speed for a given configuration.
2 So that if you have a certain configuration of flaps,
3 there's a certain speed which you can fly it at, and
4 beyond that speed, you're exceeding the -- the normal
5 operating limits of it. So that would be defined as
6 Vmax.

7 CAPT. IVEY: And since the accident the
8 procedure has been changed to include a note about
9 slowly using the rudder up to full deflection. That's
10 2-N-7. And do you know why this change was made?

11 THE WITNESS: Okay. It -- I would
12 respectfully suggest that it's not a change, it's an
13 addition. The -- the actual procedure and the guidance
14 to the pilot is still that you would accelerate to Vmax
15 in order to establish aerodynamic loads.

16 The purpose of the -- the checklist is for
17 the unsafe gear to be exposed to loads, aerodynamic
18 loads -- and of course, the faster you go, the higher
19 the loads are -- in an effort to try and lock it down.

20 The notion of side slip, which is something
21 that up until most recently we were very, very
22 comfortable with throughout the world that most pilots
23 -- all pilots were clear on what the definition is
24 because every time a pilot lands in a cross wind,
25 they're inducing a controlled side slip in the form of

1 maintaining the heading and decrabbing an airplane, as
2 was outlined in some of the slides this morning.

3 However, in various discussions that have
4 gone on in the last several months in the -- in the
5 wake of this investigation, considerations for side
6 slip have not perhaps been considered in the context of
7 steady state. And that was the purpose of clarifying
8 this particular language in the operating manual.

9 CAPT. IVEY: Again, in the A-300 flight
10 manual under "Limitations," VA is listed as the maximum
11 design maneuver speed. VA. Would you explain what the
12 term means?

13 THE WITNESS: VA is exactly as you stated,
14 design maneuver speed. It's a design reference on
15 transport category airplanes, and -- and that's why
16 it's contained in the airplane flight manual and not
17 the Flight Crew Operating Manual. It's not an
18 operational speed.

19 CAPT. IVEY: And in part, the manual contains
20 language that "allows full application of rudder and
21 aileron controls as well as maneuvers that involve
22 angles of attack near the stall should be confined to
23 speeds below VA." And I would like to say again, "full
24 application of rudder and aileron controls." Exhibit
25 2-0 -- 202 is the page that references that.

1 But there's no statement that concerns rates
2 or inputs or amounts of displacement of the rudder in
3 particular. Does the average line pilot have the
4 information contained in his flight manual about VA
5 limitations and ranges?

6 THE WITNESS: Well, again, I'd like to be
7 clear on the fact that it's a design speed, it's not an
8 operational speed, and that's why it's not in the
9 operating manual. And I believe it's not in other
10 manufacturer operating manuals as well.

11 This is something that is -- could probably
12 be more clearly answered to you from -- from Flight
13 Test or Engineering than -- than Training or Operations
14 because we're just not exposed to it on that side of
15 the -- the industry.

16 Now, the language that's in here, in the
17 flight manual, is word for word out of FAR 25 because
18 FAR 25 states that that verbiage must be in the AFM.

19 CAPT. IVEY: Do you think that VA and the
20 definition of that speed is useful to an airline pilot?

21 THE WITNESS: I do not. I think that it's
22 important to note that I've learned much more about the
23 global understanding of VA in the -- in the last few
24 months, but I also need to -- to clarify the fact that
25 since being with Airbus I've had the opportunity to

1 train airlines all over the world. And I've never had
2 a flight crew member or anyone from a training
3 department at all or flight ops department inquire
4 about VA in reference to transport category airplanes.

5 CAPT. IVEY: And prior to the accident, would
6 it be your opinion that the full application of rudder
7 and aileron as well as elevator was protected as long
8 as you were below VA?

9 THE WITNESS: No.

10 CAPT. IVEY: You were aware that that
11 protection was not afforded?

12 THE WITNESS: No, I -- I wasn't aware. I
13 mean, in -- in -- in transport flying, in operating
14 large airplanes like this, the notion of full-scale
15 applications, other than a control check on the ground,
16 are not contemplated. And so on the basis of that, I
17 hadn't considered that -- that notation whatsoever.

18 CAPT. IVEY: So in light of the accident,
19 there's been a revelation for you as I'm sure there's
20 been for many pilots about the full application of
21 rudder and its consequences?

22 THE WITNESS: But I think it's also important
23 to note that in the traditional context of -- of VA and
24 the loads and in specifically the use of rudder for --
25 for various maneuvers in the certification, VA is not

1 considered. The -- the yaw maneuvers are done right
2 out to VDMD, which is dramatically higher than VA. So
3 that in the traditional sense or perhaps the -- the
4 recall of what VA may mean, it doesn't apply to those
5 particular loads at all because they're extended much
6 beyond in the demonstration.

7 CAPT. IVEY: We've talked about maneuvering
8 speed, but prior to the accident what do you think
9 pilots' knowledge was concerning rudder limiters?

10 THE WITNESS: What the pilots -- general
11 pilots' knowledge? I should guess that it would be
12 quite clear. It's part of the transition course. It's
13 in the operating manuals. So there's no reason to --
14 to think that pilots wouldn't be aware of it. That's
15 the purpose of a transition course when -- when pilots
16 switch from one airplane to the other, is to learn the
17 specifics of the new type aircraft that they'll be
18 flying.

19 CAPT. IVEY: But I was thinking more in terms
20 of pilot's knowledge thinking that a rudder limiter has
21 been built into this airplane to reduce the amount of
22 rudder travel and in essence protect me, the pilot,
23 from being ham-footed and putting in too much rudder
24 pedal and perhaps overstressing the tail. Do you think
25 that that might have been the general knowledge of the

1 pilot population prior to the accident?

2 THE WITNESS: I think it probably is, and it
3 should remain. If the -- if the rudder is properly
4 used, a full deflection of the rudder is needed for
5 thrust asymmetry, for the purpose of the rudder, then
6 -- then the pilot should have that conclusion properly.

7 CAPT. IVEY: And staying with the rudder
8 system, how many pilots do you think use rudder on a
9 normal flight once they have put the wheels in the well
10 and are in climb, cruise, and descent prior to
11 extending the landing gear for landing on an airport?

12 THE WITNESS: Well, throughout most of what
13 you've described, the majority of the pilots are making
14 use of the autopilot at that time. But I would say
15 that by and large, certainly on our equipment that I've
16 trained and taught on each of them, the pilots do not
17 routinely use rudder to -- to coordinate because the
18 coordination is done automatically by the system.

19 However, for any cross wind landing or any
20 cross wind condition, they would certainly use it.

21 CAPT. IVEY: And the rudder pedals, is there
22 a clear explanation as to the amount of reduction in
23 rudder pedal travel on the Airbus A-300 as it relates
24 to an increased air speed? Is that fully explained in
25 the FCOM?

1 THE WITNESS: It is.

2 CAPT. IVEY: Rudder or rudder pedals?

3 THE WITNESS: Both.

4 CAPT. IVEY: So a pilot that has --

5 THE WITNESS: I need to note though, just for
6 clarification on that, the operating manual that we use
7 is not necessarily the manual that a carrier will use.
8 They may use ours, and we'll likely use ours, as a blue
9 print for drafting their own. But the document that's
10 produced by Airbus identifies the fact that both pedals
11 and rudder is reduced as the speed increases.

12 CAPT. IVEY: Yes.

13 THE WITNESS: Yes.

14 CAPT. IVEY: That leads me to my next
15 question. Are you familiar with the American Airlines
16 operating manual?

17 THE WITNESS: No.

18 CAPT. IVEY: What do you think pilots prior
19 to the accident knew about singlets and doublets and
20 triplets and rudder reversals?

21 THE WITNESS: Reversals, I'm sure they were
22 aware of the terminology. The term "singlets" and
23 "doublets" is not something that I think was fairly
24 widely known other than people with flight test
25 background.

1 CAPT. IVEY: Do you think that the entire
2 rudder system has been adequately explained in the
3 Airbus manuals and other airlines that have their own
4 manuals regarding rudder pedal travel, rudder
5 restriction, the limitations that need to be employed
6 when you're -- in the use of rudder? Any kind of
7 cautions. Do you think that's been adequately covered
8 in your manuals as well as theirs?

9 THE WITNESS: Well, I can't speak to carriers
10 because when a carrier produces their own document,
11 they don't send it to Airbus to -- to audit, if you
12 will, or to -- to ask their opinion.

13 In our manuals, I do. We have to -- we have
14 to understand that you don't just a read manual and go
15 out and fly the airplane. The next stage is the
16 training in the proper environment of the simulator or
17 the part task trainers. And throughout that period,
18 from day one, the true man-machine harmony starts to --
19 starts to gel and mature. And it's in that process
20 that each and every flight the pilot becomes more and
21 more familiar with pressures, deflections, what -- what
22 it really means to -- to speak with and listen to the
23 airplane that they're operating.

24 CAPT. IVEY: Does the FCOM provide
25 information and guidance to those carriers that use

1 your manual or develop their own regarding the light
2 pedal forces that are on rudder pedals?

3 THE WITNESS: No, because, again, to put
4 numbers is of no value whatsoever to the pilot. The
5 pilot doesn't fly on numbers. The pilot flies on feel
6 and sensation and experience that they build up each
7 and every time they're in the airplane. That's the
8 purpose of transitioning from one type to another.

9 So although from the technical point of view,
10 from the systems knowledge point of view, there are
11 numbers that are put in from -- from an actual
12 interface or -- to allow the pilot to better operate
13 the airplane, the numbers don't seem to have any
14 operational value. It's what they experience in the
15 sims and actually in the airplane.

16 CAPT. IVEY: Do you think, prior to the
17 accident, that pilots in general, airline pilots we're
18 talking about, believe that if a rudder had been moved
19 to full displacement in one direction, followed by the
20 need for an opposite and equal full displacement, and
21 having a rudder limiter system of any kind on the
22 airplane and operating below the maneuvering speed,
23 would have thought that a tail would break off an
24 airplane?

25 THE WITNESS: I don't believe, first of all,

1 that any pilot would have ever considered reversals of
2 that nature because there's -- there's no time that --
3 that it would be appropriate to do such a control
4 input. So it's -- it's a speculative question in that
5 I don't believe it would ever be something that would
6 be considered.

7 CAPT. IVEY: And is there training given by
8 Airbus related to either singlets or doublets in the
9 either initial transition or upgrade training?

10 THE WITNESS: No. In the education in
11 response to NTSB recommendations we have highlighted
12 that because it's something that has -- that we've been
13 made aware of and we're responding to recommendations
14 as we always do when -- when the NTSB submits something
15 for us to -- to look at.

16 But again, I come back to the point that
17 throughout the world pilots are not taught normally to
18 -- to use roll as a -- as a normal roll control --
19 correction, rudder as a -- as a flight control to
20 induce roll. So the notion of doublets or reversals,
21 although they're equally inappropriate to -- to pitch,
22 they also apply to rudder. And just as we haven't
23 included such information about pitch, the same applies
24 to -- to yaw.

25 CAPT. IVEY: And in the training, is there

1 ever a demonstration or a requirement to show the loss
2 of yaw dampers in an airplane --

3 THE WITNESS: There is.

4 CAPT. IVEY: -- or the demonstration of dutch
5 roll?

6 THE WITNESS: I'm not familiar what's in the
7 -- the program today. But I know that when I was based
8 in Toulouse and teaching on that airplane, we did
9 demonstrate yaw damper failures and recovery from dutch
10 roll.

11 CAPT. IVEY: And my last question is, do you
12 think that the most effective way to address training
13 in advanced maneuvers is through ground school,
14 computer-based training, or in the simulator, or any
15 combination?

16 THE WITNESS: It depends to what extent you
17 want to do the -- the upset training. Because I
18 mentioned -- as I mentioned at the onset, there is an
19 infinite number of variables that a -- that an airplane
20 can get into. One attitude which -- which would be
21 considered an upset, perhaps very, very high pitch,
22 would be an entirely different recovery based upon what
23 the energy state was, if the airplane was 150 knots or
24 300 knots.

25 So in the context of awareness, whether it's

1 to develop an appreciation by the pilots as to where
2 they are and to what the appropriate steps may be or --
3 or perhaps a buffet of -- of steps that the pilot may
4 take, then there's an argument for perhaps saying that
5 computer-based training or some sort of part-task
6 trainer may be an appropriate medium.

7 A simulator in certain conditions may well be
8 an appropriate medium if it's strictly contained in the
9 -- in the normal limits. If the instructor has got
10 solid and ample education, if the lateral and vertical
11 forces are maintained in -- in such a realm that the
12 pilot could have an expectation.

13 But the concern for using that particular
14 medium is that -- the simulator medium, is that it
15 usually implies procedure -- procedure training. And
16 in that context, that's -- that's not what the
17 manufacturers would recommend. We think that -- that
18 because there are so many variables, an awareness
19 factor is of more value.

20 So it's a long-winded and not a direct answer
21 because it's such a complex issue. I think that
22 unusual attitude training or awareness is very
23 important. I think the NTSB was very proactive. I
24 think American Airlines was very proactive to raise the
25 point in the mid '90s. However, we do have to be very,

1 very cautious and conscious of where we take that
2 particular training.

3 CAPT. IVEY: Thank you, Capt. Rockliff. I'd
4 like to turn the microphone over to Dr. Malcolm Brenner
5 for some subsequent questions.

6 DR. BRENNER: Yes, Captain. I understand you
7 reviewed the American Airlines AAMP training video that
8 was made at the end of 1997. It's a take-home video
9 for the pilots. Is that correct?

10 THE WITNESS: Just in the last couple of
11 days, that's correct.

12 DR. BRENNER: I wanted you just for a moment
13 to focus your comments to this video because we have an
14 historical interest on it. This is a video that the
15 accident pilots had. We believe the tape was made
16 about the time that they took the training. And so in
17 case -- in the event of evolution of the program, this
18 is as close as we think we can come to what they
19 learned.

20 You expressed concerns about emphasis on
21 rudder. Did you feel that in watching this video?

22 THE WITNESS: Not to what I had recalled
23 before. There was less emphasis on rudder in terms of
24 frequency of -- of discussion about rudder. However,
25 there was discussion which, in my opinion, was

1 incorrect use of rudder.

2 DR. BRENNER: What was that discussion?

3 THE WITNESS: Using it -- during the video
4 the term "coordinated rudder" was -- was redefined. To
5 me, it was a total new definition that I'd never heard
6 before. As I mentioned earlier, "coordinated rudder"
7 is -- is essentially to zero side slip or to -- to keep
8 the ball in the middle. The video defined "coordinated
9 rudder" as simply rudder in the direction of the roll.
10 And -- and unless there was -- well, that's just not
11 coordinated rudder.

12 DR. BRENNER: And you expressed a concern
13 with teaching of procedures rather than awareness. Did
14 you feel that in watching this video?

15 THE WITNESS: I did.

16 DR. BRENNER: Can you give an example?

17 THE WITNESS: Well, the steps. The presenter
18 of the video identified various steps that -- that a
19 pilot should go through in order to recover from --
20 specifically, from nose high and nose low type
21 condition.

22 DR. BRENNER: The first officer involved in
23 the accident came from a civilian background and as far
24 as we can establish did not have a background in
25 aerobatic flying. Are there particular concerns that

1 would apply to a student like this?

2 THE WITNESS: There are concerns for any
3 student regardless of what their background is if there
4 is incorrect information in the training, particularly
5 if it's a very well put together presentation with an
6 effective communicator as an instructor. When you
7 teach someone something, the importance, the
8 criticality of it being correct can't be understated.
9 And so any time something is not correct, then -- then
10 there's a liability. And that pertains to any learner.

11 DR. BRENNER: I understand that you were
12 involved in the investigation of a previous event,
13 Flight -- American Airlines Flight 903 event that
14 happened near Miami in 1997. And there is some
15 material on this in the Exhibit 2 series.

16 Do you think there were issues in common
17 between the Flight 903 event and the 587 accident?

18 THE WITNESS: Issues in common?

19 DR. BRENNER: Yes.

20 THE WITNESS: In both events, there was use
21 of rudder which -- not when the rudder should have been
22 used.

23 DR. BRENNER: Could you elaborate a little
24 bit?

25 THE WITNESS: Well, again, as I've -- I've

1 noted, rudder is used to zero yaw, zero side slip, not
2 to induce roll. In both of these cases, rudder was
3 used to augment roll, but it was very consistent with
4 what had been defined as coordinated roll insofar as
5 the AAMP presentation. And it also would be very much
6 conditioned as a result of simulator exercises if the
7 pilots had found that their normal roll control was
8 ineffective.

9 DR. BRENNER: In Exhibit 7-LL, there's Airbus
10 communications from about the time of the Flight 903
11 event expressing concerns that the tail of the airplane
12 may have sustained structural damage as a result of
13 pilot actions during the event. As a member of the
14 Airbus team involved in the investigation, were you
15 aware of these concerns?

16 THE WITNESS: I'm not sure that I have
17 Exhibit 7-LL. But as a member of the Ops group, I do
18 not recall at this time any -- any knowledge of loads.
19 We knew for sure that the airplane had gone through
20 some fairly violent maneuvering, but the Ops group --
21 we didn't discuss loads at that time.

22 DR. BRENNER: In training pilots on the A-
23 300-600 simulator, I understand that most rudder
24 training takes place at takeoff and landing speeds
25 because of the functions. Do you ever train pilots to

1 use the rudder at higher air speeds, such as 250 knots?

2 THE WITNESS: A takeoff exercise would
3 continue through the acceleration phase to the -- to
4 the final takeoff speed, which would take them up in
5 that air speed range, 230 to 240 knots, dependent upon
6 weight. The environment where an instructor may
7 introduce the abnormal, i.e. the yaw damper failures
8 or -- or any other particular anomalies, would be
9 certainly out of the takeoff range. So, yes, a pilot
10 would be exposed to it.

11 I think an important point to note with
12 regard to the -- the speed environment is that pilots,
13 regardless of which transport category airplanes
14 they're flying, realize that the airplanes operate in a
15 very, very large aerodynamic envelope. And -- and the
16 effectiveness of the controls is -- is quite dramatic
17 in terms of the amount of deflection needed to -- to
18 achieve the desired outcome.

19 So it's pretty natural for a pilot, as they
20 go through this acceleration phase, to -- to discover
21 the fact that the rudder that they need to implement
22 right at the -- at the failure incidence is quite a bit
23 different than what they need at a much faster speed
24 when they complete the acceleration phase or indeed
25 throttle back when they -- when they reduce thrust.

1 DR. BRENNER: For airlines that do teach the
2 use of rudder for roll control, what training should
3 they provide on the human factors issues involved in
4 the rudder design?

5 THE WITNESS: Well, first of all, they
6 shouldn't teach rudder for roll control.

7 DR. BRENNER: Just -- given that there may be
8 clients who would elect to do that, what
9 recommendation would you have as far as training?

10 THE WITNESS: I would be working to encourage
11 them not to do that. It just isn't a suitable teaching
12 practice unless they're looking at a condition of
13 degradation.

14 Now, the manufacturers have not said, "Do not
15 use rudder." If your normal roll control does not
16 function, it's -- it's either inoperative from a system
17 malfunction or for whatever reason, then the only thing
18 the pilots have left to induce roll is either
19 differential thrust, which is not comfortable, or to
20 utilize rudder. However, that's a fairly -- that's a
21 long path to get down to that level of degradation to
22 where a pilot would be exposed to using rudder.

23 If -- if a company -- if a carrier wanted to
24 go down that level to expose pilots to it, then for
25 sure, you would want to teach them to walk before you

1 put them in a -- in a -- in a running type condition,
2 which would mean that in very stable conditions you
3 would start out with very, very small inputs to
4 discover what the response would be with a flight
5 control that you don't use for roll.

6 DR. BRENNER: Thank you very much, Capt.
7 Rockliff. I appreciate your assistance.

8 That completes my questioning, Madam
9 Chairman.

10 CHAIRMAN CARMODY: Thank you. Are there
11 other questions for the witness from the Technical
12 Panel? Yes, Mr. Benzon?

13 MR. BENZON: Sir, we've heard some comments
14 where some may believe that an airplane like the A-300
15 could be flown with a missing vertical stabilizer and
16 rudder. Would you clarify this issue for us that may
17 be concerned about this?

18 THE WITNESS: If I understood your -- your
19 question correctly, some -- there's been comments that
20 the airplane could fly without a vertical stabilizer
21 and rudder?

22 MR. BENZON: That's correct.

23 THE WITNESS: This is the first I've ever
24 heard of it, and I couldn't respond to that.

25 MR. BENZON: I see. You don't have an

1 opinion on it at all one way or the other?

2 THE WITNESS: No.

3 MR. BENZON: Okay.

4 CHAIRMAN CARMODY: Additional questions?
5 Yes, Mr. Jouniaux?

6 MR. JOUNIAUX: Yeah. In the simulator
7 training that you conduct, do you develop any wake
8 turbulence scenario during the simulator phase?

9 THE WITNESS: In the Airbus training?

10 MR. JOUNIAUX: Yes.

11 THE WITNESS: No, because wake turbulence,
12 although there's been a lot of emphasis, and as I
13 mentioned earlier, there's been a wake turbulence
14 training aid, in large part this is an issue of small
15 airplanes. I'm talking very small airplanes. Lear
16 jet, perhaps small commuter airplanes on down. It's
17 not a -- a major issue for large transport category
18 airplanes to our data that we've received. And -- and
19 we have questioned this with our competitors as well.

20 So because it's -- it's relatively routine
21 and -- and the fact that pilots will experience
22 turbulence in the form of wake and that they're
23 normally expelled before anything dramatic occurs, we
24 have had no reason to consider putting that in our
25 simulators.

1 MR. JOUNIAUX: That's all. Thank you.

2 CHAIRMAN CARMODY: Thank you. Anything else
3 from the Technical Panel?

4 (No response)

5 CHAIRMAN CARMODY: Then we'll move to the
6 parties. Mr. Donner with the FAA?

7 MR. DONNER: Thank you, Madam Chairman.

8 Capt. Ivey asked my questions and Capt. Rockliff
9 answered them, so I have nothing further. Thank you.

10 CHAIRMAN CARMODY: All right. Thank you.
11 Mr. Ahearn with American?

12 CAPT. AHEARN: Thank you, Madam Chairman. A
13 few questions, and I'll try to move as fast as I can.

14 It is going to involve some exhibits, if you
15 need them, Capt. Rockliff. Some of them are not in the
16 two exhibits but you referred to some of the issues
17 associated with the terminology, such as "rudder
18 reversal should not be considered."

19 And I'll refer to an A-310 incident in
20 February of 1991 which involve repetitive rudder
21 movements. At the time, did Airbus consider --
22 consider modifying the VA chart and its outcomes or
23 putting a statement in its manual to explain that not
24 all flight control movements below this speed are
25 structurally safe?

1 THE WITNESS: I'm unable to comment on that
2 at that time because I had transitioned over to the
3 fly-by-wire and actually transitioned over to Miami
4 from Toulouse. So I'm not aware. Perhaps someone else
5 can respond to that.

6 CAPT. AHEARN: Okay. I'll try it with
7 another witness. But you're not aware of any documents
8 that went out, to your knowledge?

9 THE WITNESS: Not to my knowledge.

10 CAPT. AHEARN: Okay.

11 THE WITNESS: I'm not suggesting that they
12 didn't go out. I'm just stating that I'm not aware of
13 what --

14 CAPT. AHEARN: Okay. I'll -- I'll try Capt.
15 Jacob.

16 Let me move to another document that is part
17 of your exhibits. It's Exhibit 2-V as in "Victor,"
18 page seven.

19 (Pause)

20 THE WITNESS: Okay.

21 CAPT. AHEARN: This page demonstrates that
22 Airbus in fact did issue revisions to its FCOM and
23 Quick Reference Handbook after the 903 incident but
24 said nothing about the dangers of rudder reversals. Do
25 you know why at the time you did not include warnings

1 about rudder reversals and potential structural failure
2 post the 903 FCOM revision?

3 THE WITNESS: Again, I wasn't a part of
4 writing this particular document. So for reasons why,
5 I can't speak to. I know that in this same document
6 there was references to the -- the loads and -- and the
7 inappropriate use of rudder. But at that particular
8 time we were dealing, we thought, with one carrier.

9 CAPT. AHEARN: I understand that there were
10 comments but there were no changes to the FCOM. You
11 commented but you didn't change anything in your FCOM,
12 is that correct?

13 THE WITNESS: That I'm aware of. I'm not --
14 you know, I don't know.

15 CAPT. AHEARN: Okay. To that point, would
16 you please clarify how Airbus typically notifies its
17 operators of significant structural or operational
18 limitations on its aircraft? Would the FCOM be
19 appropriate documentation?

20 THE WITNESS: Can you clarify the question,
21 please?

22 CAPT. AHEARN: Well --

23 THE WITNESS: How we would communicate which?

24 CAPT. AHEARN: When -- basically, what I'm
25 referring to is the FCOM documentation. Is that how

1 you would typically notify operators of any structural
2 -- of significant structural or operational limitations
3 on your aircraft?

4 THE WITNESS: If there's an operational
5 limitation, the operating manual is -- is the
6 appropriate document for it. If it's -- if it's an
7 engineering issue, then they would be -- it would be
8 communicated to the operators through the engineering
9 channels.

10 CAPT. AHEARN: Okay. Thank you.

11 (Pause)

12 CAPT. AHEARN: I'm going to refer you back to
13 the Industry Training Aid Upset Recovery document for a
14 moment. At any place -- do you know where -- in the
15 Industry Training Aid does it state that a particular
16 use of rudder to recover from an upset situation may
17 cause catastrophic -- catastrophic failure below
18 maneuvering speed? Are you aware of that anywhere in
19 the Training Aid at all?

20 THE WITNESS: Not off the top of my head.
21 I'd have to go through the whole Training Aid. But I
22 know that there's a number of entries in the Training
23 Aid about the sensitivity of the use of rudder but the
24 specifics of the wording I can't speak to at the
25 moment.

1 CAPT. AHEARN: But nothing to your knowledge
2 about structural failure?

3 THE WITNESS: No, I'm not saying not to my
4 knowledge. I'm just saying at the moment I'm -- you
5 know, I'd have to go through it to find whether there's
6 a particular line. If you'd like, I can peruse through
7 the -- the inputs that are there.

8 CAPT. AHEARN: No. For the sake of time,
9 I'll not ask you to do that. I've read it and looked
10 through it and that's the purpose of the question. I
11 couldn't find it anywhere.

12 THE WITNESS: Well, actually, as we talk
13 about it a little bit more I think there might be. Can
14 you tell me which exhibit it is that's in there?
15 Because I'd heard earlier today that you wanted -- one
16 of the parties wanted to add a couple of pages.

17 (Pause)

18 CAPT. AHEARN: Capt. Rockliff, it's 2-Q as in
19 "queen."

20 THE WITNESS: Yeah. Thank you.

21 (Pause)

22 THE WITNESS: Just today I received just
23 before noon another couple of pages that I believe
24 Allied Pilots Association wanted to include, which is
25 the very next page, which would be, I suppose, 10.5.

1 And I think that there may be something on that page
2 that talks about loads.

3 MR. CLARK: Is that an exhibit now?

4 THE WITNESS: I'm -- Mr. Ivey, can you
5 respond to that?

6 CHAIRMAN CARMODY: I was going to ask the
7 same question. Is this a new exhibit or is this a
8 proposed exhibit?

9 CAPT. IVEY: I was handed two pages at the
10 lunch break, and I think it's from the Allied Pilots
11 Association. And the two pages are -- the two pages
12 that would follow are Exhibit 2-Q-10. And it would be
13 10-A and 10-B. It would -- those two pages would fall
14 between pages 10 and 11. 2-Q-10 and two new pages
15 would be --

16 CHAIRMAN CARMODY: Are they -- are they
17 sequential in the manual?

18 CAPT. IVEY: Yes, they are. They are -- if
19 you look in the lower left-hand corner of the Industry
20 Training Aid, 2-Q-10 is page 2.3-1. And the two
21 additional pages that they provided are 2.3-2 and 2.3-
22 3.

23 CHAIRMAN CARMODY: Does everyone have copies
24 of these two pages that we're talking -- I think we
25 need to have copies -- who does not have them? FAA

1 nods that you do. You have them. Allied Pilots, do
2 you have copies -- I guess you do since you
3 distributed. Airbus? Perhaps we could get a copy for
4 Airbus.

5 I have no objection to the exhibit, but I
6 think everyone should have a copy if we're going to
7 talk about it. Everyone has a copy? All right.

8 Airbus hasn't found it. Why don't you give
9 them another copy? FAA has one. Yes, just the next
10 table, please. Thank you.

11 Does the hearing officer have any concerns if
12 we just include these in the exhibit?

13 MS. WARD: No, Madam Chairman.

14 CHAIRMAN CARMODY: Okay. Thank you. We'll
15 include --

16 MR. CLARK: It's -- the only issue is if
17 Capt. Rockliff is familiar enough to comment about --

18 THE WITNESS: Actually, I've located my copy
19 out of my pocket.

20 CHAIRMAN CARMODY: Are you comfortable
21 commenting on this, Captain?

22 THE WITNESS: Yes, ma'am.

23 CHAIRMAN CARMODY: All right. Please --

24 CAPT. AHEARN: Can you just refer to the page
25 that you're talking about, Capt. Rockliff?

1 THE WITNESS: It's -- of the -- of the
2 Training Aid, it's Section 2, page 2.3-2. So as Capt.
3 Ivey noted, it would be the very next page.

4 And in the very last sentence of the first
5 column leading to the completion of the second column,
6 "When the rest of the airplane is symmetric, for
7 example, in a condition of no engine failure, very
8 large yawing moments would result in very large side
9 slip angles and large structural loads should the pilot
10 input full rudder when it is not needed."

11 CAPT. AHEARN: Okay. Again, I believe that
12 is the certification test that they're referring to,
13 but that does not refer to a catastrophic failure. I
14 don't disagree that would put high loads on the
15 airplane, but it does not refer to anything in the
16 Training Aid that I've been able to discover that would
17 talk about a catastrophic failure.

18 THE WITNESS: That's the reference that
19 speaks to the structural --

20 CAPT. AHEARN: Okay.

21 THE WITNESS: -- that I recall.

22 CAPT. AHEARN: Thank you.

23 (Pause)

24 CAPT. AHEARN: I just want to -- from a point
25 of clarification, I got a little off the calendar when

1 we were talking about AAMP. Were you invited to see
2 the AAMP program in 1995 or did you actually attend the
3 AAMP program in 1995?

4 THE WITNESS: No. The vice president of
5 flight operations at that time invited me to -- to
6 attend the program. And I attended that with, I think,
7 six or seven other airmen. They were all American
8 Airlines check airmen or instructors.

9 CAPT. AHEARN: Okay.

10 THE WITNESS: It did not include the
11 simulator. It was just the -- the day presentation.

12 CAPT. AHEARN: Okay. Post attending the
13 portion that you attended at the -- with the non-
14 simulator portion, when did you first provide any
15 written input to American Airlines regarding AAMP
16 training?

17 THE WITNESS: Written input?

18 CAPT. AHEARN: Correct.

19 THE WITNESS: First written input that I -- I
20 think the first written input was a letter that was
21 sent to the vice president of flight operations which
22 was his request for the three manufacturers and a
23 representative of the FAA to submit our concerns for
24 some of the aspects of AAMP that we experienced in the
25 -- in June of the following year, 1997.

1 CAPT. AHEARN: Okay.

2 THE WITNESS: However, that day I did
3 communicate to the author of the AAMP program concerns
4 about rudder in the form of what he was -- what he was
5 presenting at the high angles of attack.

6 CAPT. AHEARN: As a commentary to the
7 instructor and then written input in 1997?

8 THE WITNESS: Correct.

9 CAPT. AHEARN: Okay. And the captain -- the
10 vice president of flight from American Airlines
11 responded to you in November or October of 1997, I
12 believe. Again, the date was right after your letter
13 that came from not only you but also the other
14 manufacturers as well as the FAA. But the vice
15 president of flight did indeed respond to that letter,
16 correct?

17 THE WITNESS: He did respond. His letter was
18 dated October. It was not sent out until January of
19 the following year.

20 CAPT. AHEARN: I'm not certain that that's
21 true, but again, he did respond to your -- to your
22 letter of June of '97?

23 THE WITNESS: Correct. And we received it --
24 all of the four authors received it in January.

25 CAPT. AHEARN: Okay. And there was no

1 subsequent correspondence from Airbus regarding the
2 response that the vice president of flight provided
3 you?

4 THE WITNESS: Response? There was lots of
5 response.

6 CAPT. AHEARN: So you have subsequent written
7 documentation to the letter that the vice president of
8 flight provided you?

9 THE WITNESS: The response that we made
10 following the vice president of flight operations'
11 letter to us was -- was numerous. We started out
12 actually the very next month working on our Technical
13 Digest which would not only be for -- for his review
14 but for all pilots at American and every other carrier
15 in the world. And that was in the joint "FAST and
16 Airliner" article. We had the, as Capt. Ivey noted,
17 the Ops Performance Conference in San Francisco of that
18 year. We had communication at that same time with
19 American Airlines Flight Technical Department and the
20 chief test pilot at Boeing. And at least to our
21 understanding, from -- communicated from your Flight
22 Technical Department, that was also subsequently going
23 on at Boeing. We sent out the Training Aid in August
24 of '98.

25 So it was continuous. There was -- there was

1 a dramatic amount of response.

2 CAPT. AHEARN: Okay. But specifically to the
3 issues associated with rudder issue, there was no
4 changes to your FCOM, no documentation put into your
5 FCOM about restrictions on the rudder below V sub-A

6 THE WITNESS: The FCOM was not determined to
7 be the proper place. The Training Aid was the proper
8 place because, as we've noted before, upset training is
9 -- is -- is -- is a qualification or an education for
10 pilots. And -- and the FCOM is not an education
11 document to that extent. It's an operational
12 supplement for pilots to operate their airplanes.

13 So we put the training where the training --
14 or the training information where within the industry
15 it has become the accepted practice to put it, which is
16 in the form of training aids.

17 CAPT. AHEARN: One final question on the
18 AAMP. Can you tell me why you didn't accept the vice
19 president of flight's offer to review the AAMP
20 simulator data?

21 THE WITNESS: Why we didn't accept?

22 CAPT. AHEARN: Correct.

23 THE WITNESS: I wasn't given the option. And
24 certainly, I was taking my direction from Toulouse, and
25 no one in Toulouse had -- had provided any information

1 to that effect that we had any visibility at all of the
2 simulator data.

3 CAPT. AHEARN: So despite the fact that the
4 vice president of flight did invite you and the other
5 manufacturers -- it wasn't just Airbus, it was Boeing,
6 McDonnell Douglas, and the FAA -- to your knowledge, no
7 one at Airbus took them up on that offer?

8 THE WITNESS: Can you -- now you're saying
9 that the vice president of flight operation offered to
10 provide us with simulator information?

11 CAPT. AHEARN: Yes. In the letter that he
12 sent you on October 6th, 1997, which you say you
13 received in January of 1998. It's Exhibit 2-Charlie,
14 if you want to refer to the exhibit.

15 (Pause)

16 CAPT. AHEARN: It's page nine.

17 (Pause)

18 THE WITNESS: And can you --

19 CAPT. AHEARN: Under the heading of "Use of
20 Simulators," the last sentence in the first paragraph.

21 THE WITNESS: Mm-hmm.

22 CAPT. AHEARN: "On your next visit to our
23 flight academy we'll be pleased to show you the beta
24 readouts during this event."

25 (Pause)

1 THE WITNESS: The beta readouts was -- was
2 only a small portion of the concern that we had for the
3 use of the simulator. The -- the issue of reducing the
4 roll effectiveness or partially inhibiting or totally
5 inhibiting the roll was -- was the true issue in that
6 particular area because as a result of it the -- the
7 beta was -- was going to be questionable by the primary
8 use of rudder that would be needed.

9 But further on in the letter, it was crystal
10 clear that -- we responded to the vice president's
11 request to provide input and his response back to us
12 was his decision that he wasn't interested in our
13 inputs. And so we chose to -- to approach -- or to
14 work with your Flight Technical Department and all
15 throughout the industry, including all of the pilots at
16 American, through the -- through the facilities of our
17 Technical Digest and the -- and the Training Aid.

18 CAPT. AHEARN: Okay. One final question
19 again. You raised another issue that I want to ask on
20 the Industry Training Aid. What did Airbus do to
21 determine if its simulators could adequately represent
22 flight during the ITA, or Industry Training Aid,
23 recommended exercises?

24 THE WITNESS: I'm sorry. What did we do to
25 determine the simulators were adequate?

1 CAPT. AHEARN: Correct. There were eight
2 recommended exercises, simulator exercises, in the ITA.
3 What -- what action did you take to determine if your
4 simulators could adequately represent flight during
5 these recommended exercises?

6 THE WITNESS: Well, during the development of
7 the Training Aid, both Boeing and ourselves looked
8 seriously at our simulators. In our case, we had the
9 A-300-B4 simulator in Miami. And my colleagues who
10 were leading the project in Toulouse did it with the A-
11 310 over there as well as together. And by the way,
12 Boeing also joined us in -- in our simulator in Miami,
13 as I did in Seattle.

14 We discovered that the simulators in -- in
15 some fairly simple maneuvers were not representative of
16 what the airplane should actually be doing. In the
17 case of our A-300, it was -- it was in a full stall
18 type condition where power -- we could recover from it,
19 which -- which is just, you know, holding the control
20 column back and using power to fly out of it, which is
21 absolutely incorrect.

22 In the Boeing simulator, in a nose-low
23 condition, the airplane would continue to diverge and
24 accelerate versus converge with an increasing load.

25 So in that regard, that amplified and

1 reinforced our sensitivity to the use of simulators.
2 Insofar as what we did with the simulators afterwards
3 with the Training Aid, as -- as I noted to Capt. Ivey,
4 we chose not to use simulators for the Training Aid --
5 for upset training. We just do the academic portion.
6 And so therefore, we haven't done any validation on
7 them because we haven't conducted upset training in
8 them.

9 CAPT. AHEARN: Okay. Just a few more,
10 Captain -- question, Capt. Rockliff. Let me start off
11 with a commentary that you had stated earlier. And I'm
12 referring to the NTSB recommendation about actually the
13 creation and the need for upset recovery training. You
14 stated by the time a pilot gets to the airlines they
15 should have already experienced upset training. Would
16 you agree that the accident history associated with
17 what led to the NTSB recommendation associated with the
18 required upset training would not support that
19 statement?

20 THE WITNESS: I'm sorry. If you can just --

21 CHAIRMAN CARMODY: I don't understand the
22 question.

23 THE WITNESS: Nor do I.

24 CAPT. AHEARN: You stated that by the time
25 pilots get to an airline they should have already

1 experienced upset training. And yet, we have an NTSB
2 recommendation that highlighted a number of accidents
3 associated with loss of control and controlled flight
4 into terrain, a significant number in both categories.

5 And therefore, the NTSB came up with a recommendation
6 that said there's a need for upset recovery training.

7 I think what I'm asking you is, as you look
8 at what the recommendation coming from the NTSB, it
9 actually is inverse of what you said in your testimony
10 today.

11 THE WITNESS: Okay. Now I understand what
12 you're asking. I think the NTSB was -- was right on
13 target. They, like American, discovered that there was
14 a deficiency in the pilots' education. And it was not
15 acceptable to -- to simply leave that -- that
16 deficiency open until such time as it was corrected
17 back where it should be corrected in a -- in a pilot's
18 primary education because there was a condition out
19 there in industry where pilots perhaps have not been
20 exposed to it. They need to have this awareness
21 training. And that, I think, is what their initiative
22 was.

23 And by the same way that American made that
24 own conclusions themselves, I think the NTSB was -- was
25 on target.

1 CAPT. AHEARN: Okay. Just two more
2 questions, Capt. Rockliff. I'm going to refer you to
3 Exhibit 2-N as in "Nancy," page six.

4 (Pause)

5 CAPT. AHEARN: And in your testimony I
6 believe you stated that pilots knew this procedure was
7 talking about steady state side slip.

8 THE WITNESS: 2-N -- I'm sorry.

9 CAPT. AHEARN: 2-Nancy, page six.

10 THE WITNESS: Yeah. Have it.

11 CAPT. AHEARN: All right. And again, I'll
12 refer you back to what I believe you stated, that
13 pilots knew this procedure was talking about steady
14 state side slip, was, I believe, the terminology you
15 used.

16 THE WITNESS: Mm-hmm.

17 CAPT. AHEARN: How would you interpret the
18 words "alternating side slip"?

19 THE WITNESS: Because -- well -- Alternating
20 side slip -- first of all, if the pilot is not
21 maintaining a constant heading and if, you know, if you
22 picture yourself in a particular condition where you're
23 running through a checklist procedure, the first thing
24 you want to do is control your flight path. And the way to
25 control your flight path is through steady state side slip.

1 Now, alternating steady state side slip would
2 simply be coming back to neutral and setting up the
3 opposite direction where ultimately your heading varies
4 exceedingly little from -- from the initial and the end
5 point. And that is what is stated in the -- in the
6 procedure.

7 CAPT. AHEARN: So you believe the
8 interpretation of "alternating side slip" is the same
9 as steady -- steady side slip, just -- just reversing
10 it?

11 THE WITNESS: Correct. In other words, if
12 you're maintaining a given heading of, say, north, you
13 would establish the side slip with perhaps -- initially
14 to deflect the slip stream to try and lock the gear
15 down the airstream. And if that doesn't work, you're
16 going to alternate, still maintaining north, in the
17 opposite direction. If you didn't do that, there would
18 be tremendous gyrations that the pilot -- that the
19 flight would be going through for the exact same
20 reasons that the previous presenter had indicated, that
21 introducing yaw will create side slip and in turn
22 induce roll. And you're not going to get the side slip
23 load that's intended with -- with the procedure.

24 CAPT. AHEARN: Okay. Thank you, Capt.
25 Rockliff. One final question. Would you agree that

1 the 587 accident was not an upset recovery event, at
2 least until the vertical stabilizer separated?

3 THE WITNESS: Was not an upset event. By
4 definition of an upset, the airplane hadn't exceeded
5 the attitude parameters. So in that particular -- you
6 know, in that context, it was not upset. But the
7 airplane was not in control, so it's -- it's a
8 difficult question.

9 An upset, by definition that was established
10 with the Upset Training Aid, does apply to pitches and
11 roll figures. And -- however, if the pilot doesn't
12 wait until that particular figure is achieved before
13 they initiate a recovery. So in that context there was
14 a recovery initiated pointing in that direction.

15 CAPT. AHEARN: Oh, I would agree that it was
16 a -- a recovery -- that it was an event of recovery
17 from the conditions that the pilot was experiencing.
18 But I also agree with you that it wasn't an upset
19 recovery under the traditional definition.

20 THE WITNESS: Correct.

21 CAPT. AHEARN: Okay. Thank you, Capt.
22 Rockliff, and thank you, Madam Chairman.

23 CHAIRMAN CARMODY: Thank you, Mr. Ahearn.
24 Capt. Pitts, any questions?

25 CAPT. PITTS: Yes. Good evening.

1 THE WITNESS: Good evening.

2 CAPT. PITTS: Capt. Rockliff, earlier you
3 spoke of Exhibit 2-0, page two, the Maximum Design
4 Maneuvering Speed VA graph.

5 THE WITNESS: Right.

6 CAPT. PITTS: Approved by the DJAC. And you
7 made a comment that you were not exposed -- this was
8 not exposed to our side of the industry. Is that -- is
9 that correct, sir?

10 THE WITNESS: When I said "our side," what my
11 intent was, was the operational side. It's a design
12 maneuver speed which is used for certification and
13 development of the -- of the aircraft. And it's in
14 that context when I meant "on our side." Being after
15 certification, the airlines use the airplane and, of
16 course, the manufacturer also supplements with the
17 training. It's in that context I meant "on our side."

18 CAPT. PITTS: In your opinion, is there good
19 communications from the design and engineering side of
20 Airbus to the operational side?

21 THE WITNESS: Excellent. Examples such as
22 the operations conference that I had indicated. Not
23 just Airbus, but the other manufacturer does the same
24 thing and communicates with the operational side.
25 Definitely.

1 CAPT. PITTS: If you had -- if this chart had
2 been exposed to your side of the industry, would you
3 have taken exception with the full application of
4 rudder comment that is on the left side of the graph?

5 THE WITNESS: Would I have taken exception to
6 it?

7 CAPT. PITTS: Yes, sir. From an operational
8 perspective.

9 THE WITNESS: But it's not an operational
10 speed so there would be no reason for it to be in an
11 operational document.

12 CAPT. PITTS: So from an operator's
13 perspective, you see no -- no problem with this
14 statement being in any of the manuals that are -- that
15 are used?

16 THE WITNESS: The statement, as I'd mentioned
17 before, is word-for-word out of FAR 25. It's a
18 requirement to put word-for-word in the -- the flight
19 manual. So in that perspective, as a -- as a legal
20 certification document, that's why it's in there. But
21 the application for the -- for the end user, the
22 airline pilots, doesn't have an operational
23 consequence. And so for that reason, there would be no
24 reason to have it in the operating manual.

25 CAPT. PITTS: Now, this is -- this is in fact

1 not the flight crew operating manual.

2 THE WITNESS: The AFM, you're correct.

3 CAPT. PITTS: This -- this document here.

4 THE WITNESS: That's the -- that's the
5 airplane flight manual.

6 CAPT. PITTS: And this -- this statement on
7 -- on 2-0, page two, is not in the FCOM, did you not
8 say that?

9 THE WITNESS: That's correct.

10 CAPT. PITTS: Okay. All right. You
11 referenced the -- the certification in the FARs. I
12 take it you heard my line of questioning earlier.

13 Part 25 speaks to the design of the A-300
14 airplane "containing a number of novel and unusual
15 design features for an airplane certificated under Part
16 25 of the FARs. And special conditions are necessary
17 to establish a level of safety for the model A-300-B
18 equivalent." So to -- that established by Part 25 of
19 the FARs. Was that shared with you from the
20 Engineering Department as an operator?

21 THE WITNESS: Well, first of all, you'd
22 indicated at the beginning of what you were reading
23 that FAR 25 states specifics on the A-300-600?

24 CAPT. PITTS: As a special condition -- to
25 special flight conditions for this aircraft.

1 THE WITNESS: I don't believe that the FAR 25
2 speaks to any particular airplane anywhere. FAR 25 is
3 general for certification of all airplanes.

4 CAPT. PITTS: So Special Condition Number 25-
5 52EU16, which speaks to parameters that I just read to
6 you under Part 25?

7 THE WITNESS: Well, again, I'm -- I'm not
8 involved with the certification portion of it. The
9 specifics of FAR 25 apply to all new airplanes that --
10 that are certified. And so each manufacturer has to go
11 through the different provisions.

12 If there's an operational consequence, if
13 there's an operational component to it, then
14 definitely, it will be transferred over to the
15 operating manual. If it's just design criteria and --
16 and criteria to have the airplane certified without any
17 value, operational value, to the pilot, then it would
18 not.

19 CAPT. PITTS: Okay. Would a special flight
20 condition be transferred over the operating manual?

21 THE WITNESS: A special flight condition?

22 CAPT. PITTS: Yes, sir.

23 THE WITNESS: Yes.

24 CAPT. PITTS: If -- under the category of
25 "turbulence criteria," a reference to the "airplane

1 flight manual must include recommended procedures for
2 operation in turbulence, including turbulence
3 penetration, air speeds, flight peculiarities in
4 turbulence, and any appropriate special control
5 instructions were issued against the design," would
6 that show up in the FCOM?

7 THE WITNESS: There is reference in the FCOM
8 to turbulence penetration and in the Quick Reference
9 Handbook which the pilot would have readily available
10 to them in the pilot for thunderstorm or -- correction,
11 for rough air penetration.

12 CAPT. PITTS: Any references to limitations
13 or parameters, prohibited maneuvers, use of primary
14 flight controls, in that section, sir?

15 THE WITNESS: I don't have it available to me
16 right now, and I haven't been exposed to that airplane
17 for a number of years, so I couldn't answer that
18 question.

19 CAPT. PITTS: When did Airbus know that
20 alternating rudder side slips below VA could cause
21 structural failure to the design of the A-300-B4-605-R?

22 THE WITNESS: I'm not quite clear on your
23 question. Are you pertaining to the checklist item for
24 the unsafe landing gear?

25 CAPT. PITTS: No, sir. No, sir. I'm -- we

1 have had a number of comments here about restrictions
2 to alternating side slips. And apparently, within the
3 engineering community it was known that this
4 alternating side slip could contribute to loads in
5 excess of the structural design.

6 THE WITNESS: First of all, the engineering
7 community -- I think you'd have to ask them that
8 question. But I -- I think that it's real important to
9 be clear that we don't start redefining things like
10 alternating side slip versus rudder reversals, such as
11 coordinated rudder versus what, you know, other
12 components describe that to. And so if there was
13 information that was -- that was known, I'm not privy
14 to it. I wasn't aware in the training side.

15 CAPT. PITTS: So nowhere in the -- in the
16 operational training community were there references to
17 -- bear with me. Exhibit 7-Q, pages six and five --
18 five and six, with a 1991 event and a 1997 event where
19 the load limits reached a 1.53 and 1.55 value in
20 exceedance of ultimate limit?

21 THE WITNESS: I don't believe I have seven --
22 7-Q, did you say?

23 CAPT. PITTS: I believe that's correct.

24 THE WITNESS: I don't believe that's in my
25 package.

1 CHAIRMAN CARMODY: I don't think that's
2 listed for Capt. Rockliff, Capt. Pitts. It's not one
3 of the -- the exhibits listed for Capt. Rockliff are --
4 are not -- did not include 7-Q.

5 CAPT. PITTS: Okay. My -- my apologies. But
6 I guess the -- that information was not shared with the
7 operations and training --

8 THE WITNESS: I'm not familiar with the
9 information you're talking about, so I can't respond to
10 that.

11 CAPT. PITTS: There was no sharing of
12 information about exceeding the load limits of the
13 structure of the A-300 with rudder reversal
14 application?

15 THE WITNESS: I didn't hear of any
16 documentation on that.

17 CHAIRMAN CARMODY: Capt. Pitts, we've had
18 questions about certification and questions about
19 engineering of this witness, and this is a training
20 witness. Could we please confine your questions to
21 something that he can address --

22 CAPT. PITTS: Yes, ma'am. My apologies.

23 CHAIRMAN CARMODY: -- something that's
24 relevant. I understand, but let's -- let's move on.

25 CAPT. PITTS: As we tried to -- to make the

1 connection between what was handed over into the
2 operations manual --

3 CHAIRMAN CARMODY: Mm-hmm. I understand.

4 CAPT. PITTS: -- it's difficult to follow the
5 trail.

6 CHAIRMAN CARMODY: Yes, but I -- it's very
7 clear that we're not following the trail, so.

8 (Pause)

9 CAPT. PITTS: Referring to Exhibit 2-S, page
10 five, sir.

11 (Pause)

12 THE WITNESS: 2-S, which page, please?

13 CAPT. PITTS: Page five.

14 (Pause)

15 THE WITNESS: Okay.

16 CAPT. PITTS: In the expression of concern in
17 that letter, why was there no concern expressed about
18 structural failure, in your opinion?

19 (Pause)

20 THE WITNESS: You'll have to give me a few
21 minutes to go through the letter because I'm not
22 patently familiar with it. Can you refer me to a
23 specific part of it so I can save time?

24 CAPT. PITTS: The section which speaks to
25 rudder usage.

1 THE WITNESS: Okay.

2 (Pause)

3 THE WITNESS: Okay. I'm familiar now with
4 the paragraph. Can you repeat the question, please?

5 CAPT. PITTS: The question was, in your
6 opinion, why was there no concern expressed about
7 structural failure? It seems that the -- the crux of
8 the concern there is in departure from control flight,
9 I believe.

10 THE WITNESS: Yes, that appears to be what's
11 in here. Having not written the letter and having not
12 discussed this specific with the author, I'd be
13 speculating, so I think it would be unreasonable for me
14 to speculate on that.

15 CAPT. PITTS: Okay, sir. In a transport
16 category aircraft, would you agree that a very slow
17 speed translates to a high angle of attack?

18 THE WITNESS: Very slow speed?

19 CAPT. PITTS: Very slow speed, the reference
20 of very slow.

21 THE WITNESS: Normally, I think that, yeah.

22 CAPT. PITTS: All right, sir. Was the
23 Industry's Training Aid primary concern about the use
24 of rudder related to the potential for loss of control
25 or for structural failure considerations?

1 THE WITNESS: There were various inputs. The
2 -- the Training Aid's emphasis was on inappropriate use
3 of rudder. And any time you're using rudder to induce
4 roll, it's inappropriate, whether it's low speed high
5 angle of attack, or high speed lower angle of attack.

6 CAPT. PITTS: You referenced the 903
7 investigation. Are you familiar with the parameters of
8 the aircraft as it departed from control flight?

9 THE WITNESS: The parameters? The general
10 environment, as part of the Ops group, I don't recall
11 and I don't believe we, as the Ops group, saw the --
12 the DFDR. But I'm familiar with the general
13 parameters.

14 CAPT. PITTS: Was that aircraft in a high
15 angle of attack condition?

16 THE WITNESS: It was.

17 CAPT. PITTS: And had full left wing down
18 commands been placed for the application of rudder?

19 THE WITNESS: I'm sorry.

20 CAPT. PITTS: Had the full left wing command
21 input been placed into the flight control system prior
22 to the input of rudder?

23 THE WITNESS: Again, I didn't see the DFDR,
24 but I believe that in testimony the pilots had
25 indicated that they were -- they were trying to roll --

1 roll left.

2 CAPT. PITTS: In a high angle of attack,
3 condition, would the full left wing input into the
4 aircraft and the aircraft continuing to roll to the
5 right, would it be appropriate to use rudder in that
6 condition?

7 THE WITNESS: Not in that condition, no,
8 because they were situationally unaware of the fact
9 that they were stalled.

10 CAPT. PITTS: Did the Industry Training Aid
11 disclose that the rudder should not be used to reduce
12 roll or to counter roll induced by any type of
13 turbulence?

14 THE WITNESS: Repeat the question, please?

15 CAPT. PITTS: Did the Industry Training Aid
16 disclose that the rudder should not be used to reduce
17 roll or to counter roll induced by any type of
18 turbulence?

19 THE WITNESS: The Industry Training Aid
20 didn't reference using roll -- rudder as a roll source
21 other than if normal roll source didn't function at
22 all. It was very clear in the Training Aid that the
23 normal roll power that -- that the majority of
24 transport category airplanes have got is more than
25 sufficient to provide the roll moments necessary.

1 CAPT. PITTS: What does the Industry Training
2 Aid teach pilots about being prepared to use the full
3 control authority in an upset situation?

4 THE WITNESS: It teaches that if the full
5 control authority is necessary, the pilot should use
6 it.

7 CAPT. PITTS: Does that include the rudders?

8 THE WITNESS: And that, by the way, is pretty
9 natural for a pilot.

10 CAPT. PITTS: I would agree. Does that
11 include the rudders?

12 THE WITNESS: Again, if normal roll control
13 is not effective or is -- is disabled for whatever
14 reason, then, yes, it would include rudder. But it
15 would be rudder in the direction of the turn, not
16 reversals.

17 CAPT. PITTS: Does the Industry Trade --
18 Training Aid address and try to correct a tendency of
19 pilots not to use the full control authority which must
20 be overcome when recovering from upsets?

21 THE WITNESS: There's certainly a propensity
22 of pilots in the -- in the airline business to want to
23 be very, very smooth for very good reasons, for safety
24 and -- and passenger comfort. That is detailed in the
25 Training Aid, and -- and I think rightly so, that if

1 you have a dynamic maneuver, the maneuver will dictate
2 the amount of -- of countermaneuver that the pilot has
3 to do.

4 CAPT. PITTS: Would you agree that the
5 Industry Training Aid is consistent with the AAMP
6 teaching that rudder may be necessary at high angles of
7 attack to consist -- to assist the ailerons to roll the
8 airplane in an upset?

9 THE WITNESS: No, I would not. Now, I'm
10 going -- if I may, I'm going back to my recall of the
11 AAMP several years ago. I can't speak for it today.

12 CHAIRMAN CARMODY: Capt. Pitts, could I urge
13 you to pick up the pace a little of your
14 questions?

15 CAPT. PITTS: I'm -- I apologize, ma'am. I
16 just want to make sure I don't repeat one.

17 CHAIRMAN CARMODY: Uh-huh. Yes.

18 CAPT. PITTS: I've tried to keep up closely
19 with them.

20 CHAIRMAN CARMODY: Yes.

21 CAPT. PITTS: You mentioned use of the
22 trapezoid earlier. How does a pilot normally determine
23 the appropriate amount of rudder input?

24 THE WITNESS: Normally, the pilot doesn't
25 need to because it's done automatically for them, not

1 just done on the A-300-600 but on most new airplanes
2 with turn coordination.

3 CAPT. PITTS: Would you expect a pilot to be
4 using the trapezoid?

5 THE WITNESS: No. For normal -- normal
6 routine maneuvering? The answer to that would be "no."

7 CAPT. PITTS: Would you -- would you have
8 expected the pilots in this condition to have looked
9 and used the trapezoid?

10 THE WITNESS: In which condition?

11 CAPT. PITTS: The conditions present for our
12 aircraft 587 accident?

13 THE WITNESS: In that particular airplane or
14 in that particular event, the -- the introduction of
15 rudder initially would have driven the -- the trapezoid
16 out of the middle place, which in fact would have been
17 uncoordinated. So the -- the control input wasn't
18 necessary in the first place because the turn would
19 have been coordinated through the normal aircraft
20 systems.

21 CAPT. PITTS: So the answer was, you would
22 not expect them to have used the trapezoid or to have
23 looked at the trapezoid?

24 THE WITNESS: Well, no. No.

25 CAPT. PITTS: Would you agree that the

1 Industry Training Aid, like the AAMP, teaches that
2 rudder becomes more effective as the angle of attack
3 increases?

4 THE WITNESS: That the rudder becomes more
5 effective? The rudder is always effective. It's not a
6 function that the rudder is becoming more effective.
7 What would be correct to say is that when you get down
8 to very extreme angles of attack where there may be
9 components or parts of the wing that are starting to
10 stall, then the rudder is more effective than what the
11 normal roll control is. But since it's not a normal
12 roll control any other time and that the emphasis of
13 the Training Aid is to be unstalled in the first place,
14 it's -- it's -- it's not really a practical -- it's not
15 a practical notion.

16 CAPT. PITTS: But just in terms of
17 aerodynamics, comparing one manual to the other, that
18 they agree, would you agree that -- that they both
19 teach the rudder becomes more effective as the angle of
20 attack increases?

21 THE WITNESS: It doesn't become more
22 effective. It becomes more effective relative to the
23 roll control.

24 CAPT. PITTS: One last question. Would you
25 agree that it's reasonable to expect a pilot to use

1 whatever flight controls he feels are necessary to
2 maintain control of the aircraft unless he has
3 specifically been made aware of dangers or structural
4 failure of the aircraft in using those controls?

5 THE WITNESS: Just repeat the question one
6 more time, please?

7 CAPT. PITTS: Would you agree that it is
8 reasonable to expect that a pilot would use whatever
9 flight controls he feels are necessary to maintain
10 control of an aircraft unless he specifically has been
11 made aware of a danger of a structural failure of the
12 aircraft in using those controls?

13 THE WITNESS: If a pilot has been taught to
14 use controls in a certain way and therefore believes
15 that it's the correct way to use them and feels that
16 they should be used in a particular case, that would be
17 a correct statement.

18 CAPT. PITTS: Would you expect a pilot to use
19 whatever flight controls he has available, sir, to
20 maintain the aircraft upright?

21 THE WITNESS: Yes.

22 CAPT. PITTS: Thank you. I have no further
23 questions, ma'am.

24 CHAIRMAN CARMODY: Thank you. And Airbus,
25 any questions for your witness?

1 DR. LAUBER: Thank you, Madam Chairman. I do
2 have just a few. I'll try to make sure that we get
3 through them very quickly.

4 Capt. Rockliff, you were asked a question by
5 Mr. Ahearn regarding the 587 situation. And I think
6 the two of you ended up in agreement that this -- the
7 attitudes attained in this event did not technically
8 meet the requirements or meet the definition of being
9 an upset, is that correct?

10 THE WITNESS: That's correct.

11 DR. LAUBER: However, in looking at the
12 flight data recorder information that was shown earlier
13 by Mr. Chatrenet, specifically with regard to the
14 rudder time history, would you agree that at least the
15 initial rudder and aileron inputs made by the pilot in
16 the case of 587 were consistent with what they were
17 trained to do in AAMP?

18 THE WITNESS: Based on what I learned in the
19 simulator when I went in the simulator back in 1997,
20 they were entirely consistent with what the pilot would
21 have been conditioned for.

22 DR. LAUBER: Okay. Thank you. Capt.
23 Rockliff, you've been asked a number of questions with
24 regard to the issue of specific language with regard to
25 structural failure, and many of the references were to

1 loss of control. Is loss of control, is departure from
2 control flight in a transport category airplane a
3 serious situation?

4 THE WITNESS: Yes, it is.

5 DR. LAUBER: Why is it -- why is it a serious
6 situation?

7 THE WITNESS: Loss of control is a serious
8 situation in any airplane. But obviously, in a
9 transport category airplane, you've got a lot of
10 inertias, a lot of differences. The adage that an
11 airplane is an airplane is not quite correct. In
12 certain components of aerodynamics, that may be
13 applicable. But recovery from an unusual attitude in a
14 transport category airplane requires some pretty
15 skilled piloting.

16 DR. LAUBER: And in fact, isn't it true that
17 the accident record shows pretty clearly that during
18 recovery attempts from out of control or departure from
19 control flight situations often lead to structural
20 failure and structural damage?

21 THE WITNESS: That's true.

22 DR. LAUBER: Okay. Thank you. With regard
23 to things that are on the record in -- in writing,
24 communications between Airbus and American, could I
25 refer you again to Exhibit 2-C, page three? 2-C,

1 that's the letter from the four of you to Cecil Ewell.

2 THE WITNESS: I have it.

3 DR. LAUBER: And would you go down to page
4 three, last paragraph, the sixth line from the bottom
5 that begins, "Rudder reversals."

6 THE WITNESS: Yes.

7 DR. LAUBER: Would you read that sentence for
8 us, please?

9 THE WITNESS: "Rudder reversals such as those
10 that might be involved in dynamic maneuvers created by
11 using too much rudder in a recovery attempt can lead to
12 structural loads that exceed the design strength of the
13 fin and other associated air frame components."

14 DR. LAUBER: Does "structural loads that
15 exceed the design strength of the fin" imply
16 catastrophic failure or structural failure?

17 THE WITNESS: It's -- it's -- yes, it does.

18 DR. LAUBER: That's what it says. Would you
19 turn now to page 11 of the same exhibit?

20 THE WITNESS: Yes.

21 DR. LAUBER: Would you read the second-to-
22 the-last paragraph that begins, "In closing"?

23 THE WITNESS: Okay. This is in response to
24 our letter. "In closing, your suggestions and
25 recommendations have been carefully analyzed.

1 Ultimately, as you aware, we are charged with the
2 responsibility of the lives of our passengers and crew
3 in a real-life, everyday environment, not one which is
4 technically and optimally controlled as in a simulator
5 or academia."

6 DR. LAUBER: Did those of you who received
7 this letter find that to be an open invitation for
8 further dialogue with Capt. Ewell?

9 THE WITNESS: We did not.

10 DR. LAUBER: Thank you. With regard to --
11 would you hand the witness Exhibit 2-S, please? Two-
12 Sierra.

13 THE WITNESS: Yes.

14 DR. LAUBER: And this is a letter from Capt.
15 David Tribout, who is the A-300 technical pilot for
16 American Airlines, to Mr. William Wainwright, chief
17 test pilot at Airbus.

18 THE WITNESS: That's correct.

19 DR. LAUBER: And this letter is dated 22 May
20 1997, is that correct?

21 THE WITNESS: It is.

22 DR. LAUBER: Do you happen to recall the date
23 of the event in Miami, the Flight 903 event?

24 THE WITNESS: I do.

25 DR. LAUBER: What date was that?

1 THE WITNESS: May 12th, 1997.

2 DR. LAUBER: Ten days before Capt. Tribout
3 wrote the letter, is that correct?

4 THE WITNESS: That's correct.

5 DR. LAUBER: Would you go to the second
6 paragraph, please, that begins, "I am very concerned"?

7 THE WITNESS: Yes.

8 DR. LAUBER: Would you read that for us,
9 please?

10 THE WITNESS: "I am very concerned that one
11 aspect of the course is inaccurate and potentially
12 hazardous. As you can see from the handout pages
13 attached with this letter, it states that at higher
14 angles of attack the rudder becomes the primary roll
15 control. The program infers that aileron application
16 in these situations is undesirable since it will create
17 drag caused by spoiler deflection. The -- the
18 instructor teaches that in the event of wake turbulence
19 encounter, recovery from stall, ground escape
20 maneuvers, et cetera, the rudder should be used to
21 control roll."

22 DR. LAUBER: Okay. Thank you. And the
23 letter goes on to ask a number of specific questions
24 that obviously address a concern that Capt. Tribout had
25 at that time. Would you turn to the next page, page

1 four, please?

2 THE WITNESS: Yes.

3 DR. LAUBER: And this is Capt. Wainwright's
4 reply to Capt. Tribout, dated 23 May, the day after the
5 Tribout letter was sent. Would you read the first
6 sentence, please?

7 THE WITNESS: "I share your concern over the
8 use of rudder at high angles of attack and will be
9 pleased to talk to Paul Railsback, Tom McGroom, and
10 yourself to discuss the matter. At the moment, Monday,
11 May the 25th, would be all right. Please let me know
12 roughly what time would be convenient to you. I will
13 telephone on Monday to confirm the arrangements.
14 Regards, William Wainwright."

15 DR. LAUBER: And the remainder of that
16 exhibit is the -- are the telephone notes that were
17 taken by Capt. Wainwright that detail -- we've already
18 heard some testimony on that. We don't need to go into
19 it further.

20 Do you have Exhibit 2-V handy, Capt.
21 Rockliff?

22 THE WITNESS: Two-Victor?

23 DR. LAUBER: Victor, yes.

24 (Pause)

25 THE WITNESS: I do.

1 DR. LAUBER: Two-Victor. Okay. This is the
2 airline industry submission -- airline. It's the
3 Airbus submission to the NTSB regarding American Flight
4 903, is that correct? And as such, this submission
5 would have gone to the NTSB and to all parties in the
6 investigation, which would, of necessity, include
7 American Airlines.

8 THE WITNESS: That's correct.

9 DR. LAUBER: Is that correct? Would you
10 turn, please, to page six?

11 THE WITNESS: I have it.

12 DR. LAUBER: There's a section there that's
13 entitled, "Comments Concerning Unusual Attitude
14 Recovery Techniques." Would you read for us, please,
15 the very last paragraph, that begins, "Side slip
16 angle"?

17 THE WITNESS: "Side slip angle is a crucial
18 parameter during a recovery maneuver. This is probably
19 not well understood by many line pilots, but it has a
20 significant impact on an -- on an airplane's stability
21 and control. Large or abrupt rudder usage at high
22 angles of attack can rapidly create large side slip
23 angles and can lead to rapid loss of controlled flight.
24 Rudder reversals such as those that might be involved
25 in dynamic maneuvers created by using too much rudder

1 in a recovery attempt can lead to structural loads that
2 exceed design strength of the fin and other associated
3 air frame components. The hazards of inappropriate
4 rudder use during wind shear encounter, wake turbulence
5 recovery, or recovery from low air speed at high angle
6 of attack, parentheses, (example, stick shaker), end
7 parentheses, you should -- should also be included in
8 any unusual attitude recovery discussion."

9 DR. LAUBER: Okay. Thank you, Capt.
10 Rockliff. You had earlier testified to the effect or
11 had listed a number of communications that had taken
12 place between Airbus and American with regard to
13 specific concerns with regard to rudder usage as taught
14 during the AAMP program. I'm not going to belabor the
15 point because I think that's already in the record and
16 is adequately covered.

17 Madam Chairman, I have no further questions
18 for this witness.

19 CHAIRMAN CARMODY: Thank you, Dr. Lauber.

20 We'll move now to the Board, and I'll turn to
21 Member Hammerschmidt. Any questions for this witness?

22 MEMBER HAMMERSCHMIDT: I believe just a few
23 follow-up questions.

24 Following up, really, on some of Dr. Lauber's
25 references to the exhibits, I might mention that a

1 number of us from the Safety Board had the opportunity
2 to go through the Advanced Aircraft Maneuvering Program
3 due to the kind invitation of American Airlines almost,
4 I think, six years ago this week. I looked it up this
5 morning. It was on November the 6th, 1996.

6 And so I found my work manual, my training
7 manual in my files this morning. And something caught
8 my eye concerning the use of rudder in roll recovery
9 because I had undergone some primary flight training
10 for rudder which really emphasized and a designated
11 check airman had also made a lot of comments about how
12 important the use of rudder is. And he had flown L-10-
13 11s, 727s, Airbus aircraft, et cetera.

14 But anyway, all that aside, I believe that
15 the page that caught my eye is actually in one of our
16 exhibits. It would be in Exhibit 2-Delta, page 13.

17 (Pause)

18 THE WITNESS: Yes, sir.

19 MEMBER HAMMERSCHMIDT: Okay. There on the --
20 the -- the left side of the training manual -- and this
21 would be the AAMP training -- well, it describes it
22 there now. Under that definition, would -- would you
23 agree with what is said, beginning with, "the
24 effectiveness of the rudder as a roll control," et
25 cetera? Would you agree with all that -- all that

1 statement?

2 (Pause)

3 THE WITNESS: No, I wouldn't.

4 MEMBER HAMMERSCHMIDT: Okay. And why not?

5 THE WITNESS: Well, as the -- the
6 effectiveness of the rudder true relative to the normal
7 roll control, the aileron and the roll spoilers, on a
8 relative point of view, does become more effective.
9 But the rudder itself doesn't necessarily become more
10 effective because you're at a higher angle of attack.
11 It's just in comparison to the normal and the usual
12 roll control. So in that context, the first paragraph
13 would need to be clarified.

14 Smooth application of coordinated rudder.
15 Well, coordinated rudder is only needed if there is
16 side slip that exists. Coordinated rudder in the -- in
17 the definition of what the presenter had indicated when
18 I observed the video with Dr. Brenner is not
19 coordinated rudder. Coordinated rudder -- by simply
20 augmenting normal roll control with rudder in the same
21 direction is clearly not coordinated rudder.

22 So I do not agree with that statement.

23 MEMBER HAMMERSCHMIDT: I might mention just
24 in passing for completeness that in the -- in the
25 training manuals that we received in 1996, they did not

1 -- this particular page is virtually the same except it
2 does not include that second paragraph beginning with
3 "smooth application." That's been added sometime in
4 the -- anyway, subsequently.

5 Without belaboring that point, when you said
6 that -- more than a few times that American Airlines'
7 emphasis on the use of rudder in its AAMP training was
8 a concern to the industry group that was developing the
9 -- the upset recovery training aid and that this, as
10 has been pointed out, has been discussed with American
11 Airlines on more than one occasion. Do you have an
12 insight as to why there is this dichotomy of thought or
13 of opinion concerning the use of rudder?

14 THE WITNESS: If -- if I misled you before by
15 saying that there was a departure from American and the
16 rest of the group, that was not intended. Definitely,
17 the manufacturers. I think that there was a mixture
18 amongst the -- the airline training people who were
19 there. The arguments or the presentation and the
20 rationale that the representative from American
21 Airlines brought forward based upon his experience in
22 the simulator and as by his own -- by his own statements in
23 the video that I recalled yesterday, from his previous life,
24 the effectiveness of the rudder, is what really created the
25 dichotomy between the manufacturers and he and some of

1 the others.

2 MEMBER HAMMERSCHMIDT: Okay. Very good.

3 That's all I have.

4 CHAIRMAN CARMODY: Member Goglia?

5 MEMBER GOGLIA: Yes, Mr. Rockliff. I have a
6 few questions. Most of them are rather quick to
7 answer.

8 How long is the transition training at
9 Airbus?

10 THE WITNESS: On the A-300-600?

11 MEMBER GOGLIA: Yes. Coming from --

12 THE WITNESS: The -- the actual work days are
13 25 days at Airbus.

14 MEMBER GOGLIA: And that includes sim time?

15 THE WITNESS: That's correct.

16 MEMBER GOGLIA: Can the A-300 be dispatched
17 with the autopilot in-op?

18 THE WITNESS: I don't have an MEL in front of
19 me and I'm not current on the airplane right now. But
20 I would -- I would expect, yes.

21 MEMBER GOGLIA: Okay. And I understand I
22 have you at a disadvantage there. And -- and what do
23 you teach or do you teach location of the feet for the
24 pilots -- my next questions all deal with the feet --
25 locations of the pilots' feet when they're hand-flying

1 the airplane?

2 THE WITNESS: Again, it's hard to get into
3 the notion of primary flight training as well as the
4 transition environment that -- that we're really
5 involved with in the Part 121 world. It's good
6 airmanship, and I think that from the very first flight
7 that a pilot ever takes when they decide to become a
8 pilot that when you're manually flying the airplane,
9 that is to say you do not have the autopilot on, that
10 good airmanship would dictate that you would have your
11 feet on the rudders. Not necessarily to use them
12 unless it was a type of airplane that didn't have turn
13 coordination, but to be there as you should with all
14 controls in the event that some sort of an anomaly
15 occurs.

16 MEMBER GOGLIA: Okay. Now, the next two
17 questions go to standard operations. After takeoff and
18 before the autopilot's engaged, I take it from your --
19 from what you just said to me that you would recommend
20 feet on the pedals?

21 THE WITNESS: Absolutely.

22 MEMBER GOGLIA: Okay. What about after the
23 autopilot engaged?

24 THE WITNESS: After the autopilot's engaged,
25 I think that normal practice amongst airline pilots is

1 -- is they would monitor. They wouldn't necessarily
2 have their feet on the rudders, nor would they have
3 their hands following through on the -- on the yoke.

4 MEMBER GOGLIA: Okay. And again, on the A-
5 300, does the ailerons and the roll spoilers have
6 enough authority to overcome a jammed rudder?

7 THE WITNESS: Yes. All --

8 MEMBER GOGLIA: -- full deflection?

9 THE WITNESS: All Airbus airplanes do.

10 MEMBER GOGLIA: Okay. And you mentioned
11 several times and you just mentioned in response to one
12 of my questions about the deficiencies of some pilots,
13 that we assume that they know certain basic airmanship
14 skills they may have long forgotten or may have
15 actually been trained out of them in their previous
16 gyrations as they progress up the ladder.

17 Have you personally or Airbus corporately
18 ever surveyed your pilots coming in to understand the
19 width and breadth of that deficiency?

20 THE WITNESS: We do have a prerequisite that
21 Airbus defines at the sale of an airplane insofar as
22 the training is concerned because your first question,
23 which was how long a course is, is predicated on a -- a
24 current and qualified pilot on a transport category
25 airplane. And with the datums that are established for

1 both first officer and captain in terms of hours and --
2 and the type of equipment, that's the basis for which
3 the course was designed.

4 With that, there's an expectation that the
5 pilots have gained certain skills and have matured
6 certain skills in normal piloting.

7 MEMBER GOGLIA: Now, as a follow-on to that,
8 now that we're selling Part 25 airplanes to Part 91
9 operators, have you discussed any changes that you need
10 to make in that training program because of the --
11 because of what's been happening?

12 THE WITNESS: The -- the training for Part 91
13 operators, you're talking in terms of corporate jets
14 and private airplanes and that? Yeah, that's being
15 managed out of -- out of Toulouse, as is all of our
16 training policy and training production. We actually
17 implement in -- in Miami, but all of our direction
18 comes out of our headquarters where -- where we have a
19 production and R and D department. And they are
20 looking at that as the -- as the Corporate Jet Program
21 moves forward.

22 MEMBER GOGLIA: And have you discussed ways
23 to mitigate the deficiencies that -- that may pop up?

24 THE WITNESS: That, I think, is an industry
25 issue as well. You're talking in terms of, perhaps,

1 deficiencies of a pilot's education of becoming a pilot
2 versus transition from type to type? I think that
3 that's a issue that the whole industry was looking at
4 very closely prior to September the 11th last year when
5 we were starting to end up in an area where there was a
6 global shortage of pilots. Certainly, we've
7 experienced something quite different since then.

8 But once the economy gets back on its feet
9 and -- and more people get back into airplanes and the
10 pilots start getting back in the cockpits, I think that
11 we will have to look at that.

12 MEMBER GOGLIA: Okay. No further questions.

13 CHAIRMAN CARMODY: Member Black?

14 MEMBER BLACK: Thank you, Madam Chairman.

15 Just a couple, Captain. You mentioned a few
16 minutes ago that -- that you and Boeing looked at your
17 simulators during this process to try to determine
18 their validity in certain parts of the envelope. Or
19 did you get outside the envelope or were you looking at
20 it inside the tested envelope?

21 THE WITNESS: That's correct, sir. We were
22 looking inside the -- the envelope. But what we were
23 -- well, when I say "inside the envelope," maneuvers
24 that we would expect would be inside the envelope for
25 just how our simulators, knowing that -- that our

1 motivation is to have absolutely top-performing
2 equipment. And in just two examples of -- of a number
3 of iterations, we discovered where the simulators were
4 not in fact valid representations.

5 MEMBER BLACK: Is this the same comment you
6 made, I think -- I know you don't have it before you,
7 but you made a comment in your -- in the transcript of
8 the interviews with Capt. Ivey about that Boeing had
9 tested the Airbus 300 -- Airbus and Boeing had tested
10 the 300 and the 75-76 simulators and found that they
11 did not behave as expected in common upset scenarios.
12 That's the same thing you're talking about --

13 THE WITNESS: It is, yeah. But to refine it
14 more specifically, there were -- there were two
15 maneuvers that I identified this evening, one being
16 that in the 757 we placed the simulator in a nose-low,
17 energy-increasing type scenario just to get a feel for
18 how the air -- how the simulator felt. And -- and --
19 and very basically, what the simulator should have
20 responded with is it should have increased the load
21 factor even though we wouldn't feel that because the
22 airplane was trimmed for a lower speed. In fact, it
23 diverged. It continued to open up in the -- in the
24 acceleration downwards.

25 And then in the Airbus, we -- we took it back

1 to a stall condition and simply continuing to hold the
2 control column aft, in other words, to exceed the
3 critical angle of attack. We were able to fly out of
4 it with power, and clearly, that's not correct, either.

5 MEMBER BLACK: Okay. Have you -- do you have
6 knowledge of any other airline that has modified a
7 simulator code to facilitate some sort of upset
8 training?

9 THE WITNESS: I do not have knowledge of
10 that.

11 MEMBER BLACK: Have you ever asked?

12 THE WITNESS: No, I haven't. No, I haven't
13 asked.

14 MEMBER BLACK: You train a lot of people, and
15 I guess from all over the world, Airbus has, one way or
16 another. Have you -- how common is it -- well, I guess
17 I would ask this in -- in with training and also I'm
18 sure you review upsets that occur with your aircraft
19 all over the world like you did the one on 903,
20 American Airlines Flight 903. How common is it for
21 pilots to essentially respond to the wrong upset event?

22 In other words, they're in a roll event and they
23 respond to a wind shear, or vice versa. Is that
24 common?

25 THE WITNESS: I can't respond to -- to that

1 to give you a qualified answer that they would actually
2 identify an event as being something different and
3 therefore inappropriately respond. I think it's --
4 it's reasonable to -- to look from a human factors
5 point of view that -- that the very motivation of the
6 NTSB in the early '90s, recognizing that pilots weren't
7 recognizing certain conditions, you know, warranted the
8 fact that education should occur. So I think that, you
9 know, definitely, the possibility exists. 903 was
10 clearly a case where the crew --

11 MEMBER BLACK: That was --

12 THE WITNESS: -- inappropriately --

13 MEMBER BLACK: -- that was the next question.
14 Was the response in 903 appropriate? You were on the
15 Ops group.

16 THE WITNESS: No.

17 MEMBER BLACK: Could you tell us a little bit
18 about what happened with regard to response? Don't get
19 into all of the data, but what -- what the situation
20 was and what they should have done, you think?

21 THE WITNESS: Well, the -- in the case of
22 Flight 903, the airplane was at 16,000 feet entering
23 into a holding pattern with decreasing energy that the
24 crew didn't recognize. Decreased back to the point
25 that it was entering into a stall condition. What the

1 pilots recognized and perceived due to weather in the
2 area was a turbulence-related event that they deemed to
3 be a microburst. And so they tried to facilitate or
4 they tried to input a microburst recovery.

5 Certainly, a microburst doesn't exist at
6 16,000 feet. That's an event that occurs close to the
7 ground, for one. Secondly is -- is the energy
8 awareness, that -- that the crew were not in the loop
9 with at that particular time, had them in a condition
10 that had they properly identified it, they would have
11 simply had to complete a stall recovery. And by simply
12 checking forward on the control column, that single
13 item, they would have recovered and successfully flown
14 away.

15 MEMBER BLACK: Thank you, sir. I think
16 that's all here. Thank you.

17 CHAIRMAN CARMODY: All right. Thank you,
18 Member Black.

19 Are there any additional questions from any
20 of the parties? And I would remind you, they can be
21 questions not already asked or answered. Starting with
22 the FAA?

23 (No response)

24 CHAIRMAN CARMODY: American?

25 CAPT. AHEARN: No thank you, Madam Chairman.

1 CHAIRMAN CARMODY: Allied Pilots?

2 CAPT. PITTS: No, thank you.

3 CHAIRMAN CARMODY: Airbus? How about the
4 Technical Panel? Worn you out, have we?

5 Well, I think it's time to adjourn for the
6 evening. We've gotten through three witnesses today.
7 We have 18 to go. So at this rate, we'll be here till
8 Monday. However, I'm confident we will make more
9 progress in the next few days.

10 We will resume tomorrow morning at eight a.m.

11 Thank you.

12 (Whereupon, at 7:35 p.m., on October 29,
13 2002, the proceedings were adjourned, to reconvene at
14 8:00 a.m, on October 30, 2002.)

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