UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

OFFICE OF ADMINISTRATIVE LAW JUDGES

In the matter of:	
PUBLIC HEARING IN THE MATTER OF THE LANDING OF US AIRWAYS FLIGHT 1549, N106US, IN THE HUDSON RIVER, WEEHAWKEN, NEW JERSEY, JANUARY 15, 2009	SA-532

NTSB Board Room and Conference Center
490 L'Enfant Plaza
Washington, D.C. 20024

Tuesday,
June 9, 2009

The above-entitled matter came on for hearing, pursuant to notice at 9:00 a.m.

BEFORE: ROBERT L. SUMWALT, Chairman
ROBERT BENZON, Hearing Officer, Investigator-in-Charge
JOHN DeLISI, Board Member
JOSEPH M. KOLLY, Board Member

APPEARANCES:

Technical Panel:

ROBERT BENZON, NTSB, Office of Aviation Safety
DAVID HELSON, NTSB, Air Safety Investigator, Operations/Human Performance Co-Chair US Airways Flight 1549 investigation, Office of Aviation Safety
NICOLAS MARCOU, BEA (Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile)
BRIAN MURPHY, NTSB, National Resource Specialist – Aircraft Structures, Office of Aviation Safety
JOHN O'CALLAGHAN, NTSB, National Resource Specialist - Aircraft Performance, Vehicle Performance Division, Office of Research and Engineering
JASON FEDOK, NTSB, Survival Factors Investigator, Office of Aviation Safety
MARK GEORGE, NTSB, Survival Factors Investigator, Office of Aviation Safety
KATHARINE A. WILSON, NTSB, Air Safety Investigator, Operations/Human Performance Co-Chairman of US Airways Flight 1549 Investigation, Office of Aviation Safety
HARALD REICHEL, NTSB, Aerospace Engineer, Powerplant Group Chairman of Hudson River Flight 1549 Investigation, Office of Aviation Safety

Parties to the Hearing:

PAUL MORELL, US Airways
RUDY CANTO, Airbus
DAN SICCHIO, US Airline Pilots Association
CANDACE KOLANDER, Association of Flight Attendants
BRUCE MILLS, CFM International
HOOPER HARRIS, Federal Aviation Administration

PETER KNUDSON, Public Affairs Specialist

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P R O C E E D I N G S

(9:00 a.m.)

CHAIRMAN SUMWALT: Well, good morning, ladies and gentlemen, and welcome. My name is Robert Sumwalt and I am a Board Member of the National Transportation Safety Board, and it is my distinct pleasure and honor to serve as Chairman of the Board of Inquiry for this public hearing.

This morning we open a public hearing concerning the accident involving US Airways Flight 1549 on Airbus A320 that made a forced landing, an emergency landing, on the Hudson River, on January the 15th of this year.

This hearing is being held for the purpose of supplementing the facts, the conditions, and the circumstances surrounding this accident. This process will assist the Safety Board in determining the probable cause of the accident, and in making any recommendations to prevent similar accidents in the future. No determination of cause will be rendered during these proceedings. While airline accidents are rare events, they are widely publicized and scrutinized by experts around the globe.

This event was made even more exceptional by the spectacular nature of the landing on the river, along with the significant fact, the very significant fact, that there were no fatalities.

Along those lines, I'd like to take a moment to recognize and welcome the Flight 1549 passengers and their family

members who are present in our audience today, along with those that are viewing the proceeding via our web cast.

While we are grateful that this event had a positive outcome, we are also aware that this event has been very difficult for many of you, and as we proceed through the Board's investigation, I want to assure you that we will conduct a thorough investigation to hopefully prevent others from going through what you have been through, and that is why we are here.

When a transportation accident occurs, it is the responsibility of the NTSB to determine what happened, why it happened, and what can be done to prevent similar accidents in the future. A public hearing is one tool that the NTSB may use to complete an accident investigation, and the purpose of this hearing is two-fold.

First, the issues that will be discussed serve to assist the Safety Board in developing additional factual information that will be analyzed for the purpose of determining probable cause of the accident.

And, secondly, this hearing also provides an opportunity not only for the aviation community, but for the traveling public, as a whole, to see inside of the NTSB's investigative process.

As an additional point of information, I'd like to note that I was, for a number of years, employed as a pilot for US Airways. In fact, I even flew the accident aircraft on occasions. By way of clarification, though, I want to add that I have no

financial interest in or relationship of any type with US Airways and have not had such an interest or relationship since leaving US Airways over four years ago.

That said, I should note that, in accordance with the requirements of the Standards of Conduct, the NTSB's Designated Agency Ethics Official carefully reviewed the propriety of my serving as chairman of this Board of Inquiry for this hearing. That review found there was no conflict of interest or reason to believe that my impartiality or that of the Board should be questioned. As are my fellow Board Members and the remainder of the Board staff, I am committed to an impartial and a complete investigation of this accident.

Now, to the matter at hand: in preparation for this hearing, I flew through the accident scenario in a flight simulator. I've listened to the Cockpit Voice Recorder in real time and as an experienced pilot, I can tell you this flight crew had a lot going on. They had a lot going on in a very short period of time. And, in considering what could have been done differently, there is certainly no intention by the Safety Board to diminish the crew's and the first responder's extraordinary success in saving the lives of all passengers and crew that day.

We must learn from this accident, not only what went right but what might be able to be done to improve it and learn from it so that it can be improved even more so next time. Neither I nor any other Safety Board personnel will attempt during

this hearing to analyze the testimony received, nor will any attempt be made at this time to determine the probable cause of the accident. Such analysis and cause determinations will be made by the full Safety Board after considering all of the evidence gathered during our investigation.

The final report of the accident, reflecting the Safety Board's analysis and probable cause determinations, will be considered for adoption by the full Board at a public meeting right here in this board room at a later date.

These proceedings tend to become highly technical affairs, but they are an essential part of the process in completing an investigation and seeking to reassure the traveling public that everything is being done to improve the safety of the airline industry.

The purpose of this inquiry is not to determine the rights or liability of private parties, and matters dealing with such rights or liability will be excluded from these proceedings. And I want to emphasize that this hearing is non-adversarial; it is a fact-finding examination. Over the course of the hearing, we will collect information that will assist the Safety Board in examining the safety issues arising from this accident.

Specifically, we will concentrate on the following areas: pilot training regarding ditchings and forced landings on water; certification standards for transport category airplanes regarding ditchings and forced landings on water; cabin safety,

including training, procedures, and equipment; bird detection and mitigation efforts; and certification standards for bird ingestion into transport category airplane engines.

Now for a few introductions: first, I'd like to recognize two of my Safety Board colleagues, who are with us today. We have the Honorable Mark Rosenker, who is the Acting Chairman of the NTSB, standing in the back of the room, and the Honorable Debbie Hersman, a Board member of the NTSB, also in the back of the room.

I'd now like to introduce those who will be assisting me on the Board of Inquiry. To my right is Dr. Joe Kolly, the Acting Director of the NTSB's Office of Research and Engineering; and, to my left, Mr. John DeLisi, Deputy Director of the NTSB's Office of Aviation Safety.

Members of the Technical Panel, seated over here, with the exception of Bob Benzon, who is the Investigator-in-Charge, the Technical Panel, we have Mr. Robert Benzon, the Investigator-in-Charge. Back to my right, Captain David Helson and Dr. Katherine Wilson, who are both co-chairmen of the Operations and the Human Performance Group; Mr. Brian Murphy, Structures Group Chairman; John O'Callaghan, Aircraft Performance Specialist; Mark George, Wildlife Factors Group Chairman; Jason Fedok, Survival Factors Group Chairman; Harry Reichel, Powerplants Group Chairman; and Mr. Nicolas Marcou, the French Accredited Representative of the Bureau d'Enquets et d'Analyses, of course,

the BEA, the French counterpart of the NTSB.

Mr. Bob Benzon, who I mentioned earlier, will not only serve as the -- he is the Investigator-in-Charge for this investigation, but he will also serve as the Hearing Officer for this hearing. The biographies of the Board of Inquiry and the Technical Panel are located on the NTSB's website, www.ntsb.gov. Peter Knudson is here from the Safety Board's Office of Public Affairs to assist in matters dealing with the media. Eunice Bellinger will provide administrative support, as needed. Erik Grosof, from the NTSB's Office of Transportation Disaster Assistance, is providing assistance to the Flight 1549 passengers and family members that are here.

Federal regulations provide for the designation of parties to an NTSB public hearing. In accordance with these regulations, those persons, governmental agencies, companies, and associations whose participation in the hearing which are deemed necessary in the public interest are designated as parties.

The parties assisting the Safety Board in this hearing have been designated in accordance with these regulations, and they have been selected for their technical expertise in their respective fields.

I will now call, in alphabetical order, the names of the parties to the hearing and, as I call the name of each party, I will ask that the designated party spokesperson please give your name, your title, your affiliation for the record. Airbus?

CAPT. CANTO: Good morning, Mr. Chairman. I'm Rudy Canto, Jr., Director of Flight Operations Technical for Airbus Americas.

CHAIRMAN SUMWALT: Thank you, Captain Canto.

Association of Flight Attendants?

MS. KOLANDER: Good morning. Candace Kolander, Coordinator, Air Safety, Health and Security, Association of Flight Attendants.

CHAIRMAN SUMWALT: Thank you, Ms. Kolander.

CFM International?

MR. MILLS: Bruce Mills, CFM Product Engineering Manager, GE.

CHAIRMAN SUMWALT: Federal Aviation Administration?

MR. HARRIS: Good morning, Mr. Chairman. My name is Hooper Harris. I'm the Acting Director of the Office of Accident Investigation.

CHAIRMAN SUMWALT: Thank you, Mr. Harris.

US Airline Pilots Association?

CAPT. SICCHIO: Good morning. Captain Dan Sicchio. I'm the Party Coordinator for the US Airline Pilots Association.

CHAIRMAN SUMWALT: Thank you, Captain Sicchio.

US Airways?

CAPT. MORELL: Good morning, Mr. Chairman. Paul Morell, the US Airways Captain.

CHAIRMAN SUMWALT: Thank you, Captain Morell.

I'd like to thank publicly all of the private and governmental agencies that have supported the Safety Board throughout this investigation. Last week, the Board of Inquiry held a pre-hearing conference in this Board Room and it was attended by the Board of Inquiry, the Technical Panel, and by representatives of the parties.

During that conference, the areas of inquiry and the scope of the issues to be explored at this hearing were delineated and the selection of the witnesses to testify on these issues was finalized.

As we begin this morning, we will start by the Investigator-in-Charge -- Mr. Benzon will summarize certain facts about the accident and the investigative activities that have taken place to date. Following this, the first witness will be called.

The witnesses have been selected because of their ability to provide the best available information on the issues of aviation safety pertinent to this accident investigation. Each witness will testify under oath and will serve on panels devoted to specific topic areas.

The Technical Panel will be the first to question the witnesses. After the Technical Panel, each party will, in turn, have the opportunity to question the witnesses, and the Board of Inquiry will be the last to question the witnesses.

As Chairman of the Board of Inquiry, I will be

responsible for the conduct of the hearing. I will make all rulings on the admissibility of the exhibits and pertinence of the proffered testimony, with the assistance of the NTSB General Counsel, Mr. Gary Halbert, who is seated behind me, and all such rulings will be final. The record of the investigation, including the transcript of the hearing and all exhibits entered into the record, will become part of the Safety Board's public docket and will be available on the NTSB's website. Additionally, all of the presentations will be available on our website after the hearing, which is also being web cast at www.ntsb.gov.

Now, witnesses who have completed their testimony should realize that they may be subject to recall if the need arises and therefore, please do not leave unless you've checked with our Hearing Officer, Mr. Benzon.

In closing, I'll follow my own example here. We ask that everyone please silence your electronic devices that you may have with you and also, please make a mental note of the exits from this room in the event that they may be needed in an emergency.

Mr. Benzon, are you ready to summarize the investigation and enter exhibits into the public docket?

HEARING OFFICER BENZON: Yes, sir. The exhibits are in the docket and the docket has been opened.

CHAIRMAN SUMWALT: Please proceed.

HEARING OFFICER BENZON: Good morning. I would like to

present a short summary of the Safety Board's investigative activity to date regarding US Airways Flight 1549 and some goals of this hearing.

On January 15th, 2009, at 3:27 in the afternoon, US Airways Flight 1549, an Airbus A320-214, registered as November 106US, experienced multiple bird strikes following takeoff from New York's LaGuardia Airport. The birds were ingested by all of the engines and caused an immediate and near total loss of thrust. Due to the thrust loss, the airplane was unable to maintain level flight. The flight crew subsequently landed the aircraft in the Hudson River opposite the Intrepid Sea, Air, and Space Museum in New York City. However, the landing actually occurred across the state line that divides the river in New Jersey.

(Slide.)

HEARING OFFICER BENZON: The next four slides depict the flight as a green dotted line and the bird flock as a series of red dots. The flock was flying from the upper right-hand corner to the lower left-hand corner of the screen. The 150 passengers and five crew members evacuated the aircraft and were rescued by the local ferry operators in the immediate area. One flight attendant and four passengers received serious injuries during the touchdown.

Examination of the ships' logs' entries revealed that the ferry, Thomas Jefferson, arrived first to the airplane about three minutes after the water landing occurred. The ferry, Thomas

Kean, arrived two minutes later; the ferry, Moriah Smith, arrived one minute after the Thomas Kean; and the ferry, Athena, arrived one minute later. The logs indicate that by 4:20 p.m., all passengers and crew members were off the airplane. Flight recorders were recovered from the aircraft intact and in good working order.

The CVR revealed that the elapsed time from takeoff to the bird strikes was a little over one and a half minutes. The time from the bird strikes to touchdown in the water was about three and a half minutes. The birds struck the aircraft at an altitude of about 2700 feet. During and following the evacuation, the aircraft was drifting down-river at a speed of 1.6 miles an hour.

During the rescue operation, the airplane was lashed to tugboats and fire boats to keep it afloat. River current drove the airplane and boats toward the Manhattan shoreline and a tug then pushed the airplane to the Battery Park shore, where it was tied to a pier near the World Financial Center in lower Manhattan, and this was about three and a half miles from the touchdown point.

In the days following the accident, the aircraft, minus the left engine, which had been torn off during the impact with the water, was lifted onto a barge and transported to a docking location on the New Jersey side of the river.

There, the wings, horizontal stabilizer, vertical

stabilizer, and the right engine were removed. The left engine was recovered from the river three days after the accident. Both engines were sent to the General Electric facility in Cincinnati, Ohio, for investigative teardowns. The rest of the wreckage is in storage in Kearny, New Jersey, where it was examined carefully by NTSB Structures and Survival Factors Investigative Teams.

Extensive interviews with the flight crew revealed that the initial takeoff was completely normal until the first officer spotted a group of dark birds slightly to the right of the flight path. In statements to the Safety Board investigators, the captain stated that he saw the birds an instant later and he said that the flock filled his wind screen. He indicated that he had no time to react before he felt and heard the birds colliding with the airframe. He also described the feeling of an immediate and dramatic loss of thrust.

He stated that he immediately took control of the airplane from the first officer and transmitted a May Day call to the departure air traffic controller. He then described directing the first officer to begin emergency procedures for dual engine failure. The captain soon concluded that a landing in the river was the safest alternative available. During the course of the investigation, flight simulations were conducted.

These flight simulations revealed that a successful return to LaGuardia or a diversion to Teterboro Airport was not assured. Interviews with the three flight attendants revealed

that the overall evacuation was orderly. In general, they stated that they heard a thud or thuds and then the airplane became very quiet. One noticed that the airplane was descending. When they heard the captain call brace for impact, they began to shout brace, brace, heads down, stay down. One forward flight attendant described the touchdown as very firm and the aft flight attendant described the touchdown as being violent.

None of them realized that they were -- that the airplane was in the water until they looked out the windows. The subsequent evacuation of the cabin was rapid and successful. However, several problems complicated the evacuation effort. Cargo compartment structure had been pushed up through the floor of the rear of the airplane and that resulted in injuries to the aft flight attendant. The aft pressure bulkhead of the fuselage was compromised during the impact and water began to immediately enter the cabin area.

Although one read door was cracked during the evacuation, the vast majority of the water that entered the cabin came through the torn aft pressure bulkhead. This water caused the fuselage to float tail-down and precluded the use of the two aft slide rafts. To provide investigators with a second perspective regarding the evacuation, a passenger will testify later this morning about his experience exiting the airplane after landing.

The flight data recorder revealed no anomalies in the

operation of the two General Electric CFM56 engines during the accident flight up until the time the birds were ingested. Before and during assembly, Canada goose remains were found in both engines. DNA studies revealed that at least one male and one female goose were ingested into the left engine and at least one male goose was ingested into the right engine. Further determination of the total number of geese that were ingested during the accident may not be possible.

The U.S. Department of Agriculture and the Smithsonian Institution assisted us greatly in these identification efforts. Both engines showed soft body damage on compressor blades and some of the compressor blades were bent. Other damage occurred also in the engines.

Two days before the accident, one engine experienced a compressor stall in flight. Subsequent maintenance on that engine before the accident flight included the replacement of a temperature probe in accordance with approved procedures. Maintenance tests following this replacement revealed no anomalies, and investigators have found no evidence to indicate that this earlier compressor stall was related to the accident two days later.

In addition, an examination of the aircraft's maintenance records revealed that the engines on the airplane complied with all FAA airworthiness directives and manufacturer advisory bulletins in effect at the time of the accident.

Extensive examinations of the structure of the aircraft following the accident revealed significant damage to the underside of the rear fuselage. This damage is consistent with the final rate of descent of the aircraft. A significant portion of this hearing will deal with certification aspects of transport category aircraft with regard to water landings. The Safety Board would like to explore the certification requirements applicable to water landings to better understand what scenarios they cover and whether they are comprehensive enough to reasonably ensure the safe exit of passengers into rafts during an evacuation.

Additionally, we also seek to understand how the structural and operational capabilities of transport category airplanes are evaluated against these requirements. These questions apply to both the airplane design and the training of flight crews regardless of the type of airplane. We desire to know Airbus's thoughts on these matters, as well as the FAA's and DIOSO's (ph.) to determine how lessons learned in this accident can be applied to achieve safety approval.

In closing, I'd like to show an animation we put together. It's of the ground track of the accident flight beginning shortly before the time of the bird strikes. On the screen, you'll see an aerial photograph of the Hudson River area, a moving yellow line that will represent the aircraft ground track, and you'll also see selected quotations from the cockpit voice recorder and that's from the transcript.

We're not allowed, by law, to play that over the air. And you'll also hear selected air traffic control transmissions orally. Near the end of the flight, the animation transitions to surveillance video from Pier 88, which captured the landing. The airplane speed, altitude and local time are displayed in the lower portion of the screen.

And, Tom, if you could, run that, please?

(Animation played.)

HEARING OFFICER BENZON: Play that touchdown, again, I believe.

(Animation played.)

HEARING OFFICER BENZON: Mr. Chairman, that's all I have.

CHAIRMAN SUMWALT: Thank you, Mr. Benzon. I want to reiterate something that Mr. Benzon said, and that is sometimes there is confusion over this. The audio that you heard there was not a cockpit voice recorder. That was the communications between air traffic control and Flight 1549, so that's what that was. I just want to reiterate that.

Mr. Benzon, thank you for your statement. I assume now we will pause for a moment so you can come over here. Is that what you were going to do? We'll pause and let Mr. Benzon come join the Technical Panel and Ms. Bellinger will get set up for our first witness.

(Pause.)

CHAIRMAN SUMWALT: And Mr. Benzon, thank you very much. Would you please call the first witness?

HEARING OFFICER BENZON: The Board calls Chesley Sullenberger. Sir, would you raise your right hand?

(Witness sworn.)

HEARING OFFICER BENZON: Please have a seat. And Captain, before we begin the questioning, could you give us your full name and occupation for the record?

CAPT. SULLENBERGER: Chesley B. Sullenberger, III, Captain, US Airways.

HEARING OFFICER BENZON: Thank you, sir. I believe Dr. Wilson will begin the questioning.

TECHNICAL PANEL QUESTIONS

DR. WILSON: Yes. Thank you, Mr. Benson and Mr. Chairman. Good morning, Captain Sullenberger. Thank you for being here with us today.

CAPT. SULLENBERGER: Good morning, Dr. Wilson.

DR. WILSON: As we just heard, Mr. Benzon highlighted some of the details of the accident event, and we'd like to ask you some additional questions to get your insights on some of the events that occurred on January 15th. Can you please begin by describing your experience as a pilot and also your experience at US Airways, what airplanes you've flown and how many hours you have?

CAPT. SULLENBERGER: I learned to fly at 16, served in

the United States Air Force as a fighter pilot, was hired by PSA, a predecessor company, in 1980. Been there 29 years now, at US Airways. I'm a captain currently on the Airbus. I'm type rated in the Airbus, Boeing 737, DC9, MD80, BAe 146, and Learjet. I have approximately 20,000 hours of flying time.

DR. WILSON: Great. Thank you. According to the CVR transcript, immediately after the bird strike, you called for the ignition to on and to start the APU. This was before beginning the checklist. Can you explain your decision to do this?

CAPT. SULLENBERGER: From my experience, I knew that those two steps would be the most immediate help to us in this situation.

DR. WILSON: And you next commanded control of the aircraft and then called for the dual engine failure checklist. How did you know that this was the appropriate checklist to call for?

CAPT. SULLENBERGER: From my experience, from my training, I knew that this was an ECAM exception and that it required First Officer Jeff Skiles to reference the quick reference handbook.

DR. WILSON: While communicating with ATC, you mentioned that you were examining different options of where you could potentially land. What were the options that you were choosing and why did you finally choose the option of landing on the Hudson River?

CAPT. SULLENBERGER: The first option, of course, was to return to LaGuardia. I took a look out the left window at the landmarks, at the distance remaining from where we were to LaGuardia, and the fact that we were already at low altitude, at low air speed, heading away from the airport, and when I took control of the airplane with the airplane still in a climb attitude but without the climb thrust in the airplane, our air speed began to decay rapidly. In order to lower the nose and retain a safe flying speed, our rate of descent necessarily increased dramatically.

Looking at where we were and how much time, altitude, and distance would be required to turn back toward LaGuardia and then fly toward LaGuardia, I determined quickly that that was going to be problematic, and it would not be a realistic choice, and I couldn't afford to be wrong. Once I had turned toward LaGuardia, it would have been an irrevocable choice, eliminating all other options. I had to make sure I could make it before I chose that option. I decided I couldn't.

DR. WILSON: All right, thank you.

CAPT. SULLENBERGER: And, as to Teterboro, it was too far away. The only option remaining, the only place in a highly developed, metropolitan area, long enough, wide enough, smooth enough to land was the river.

DR. WILSON: Although you did not get to the ditching portion of the checklist, you did call for configuring the

airplane for landing and you asked First Officer Skiles to put out flaps. At one point he mentioned that you had Flaps 2 and asked you if you wanted more. You made the decision to stay at Flaps 2. Can you describe your decision to do that?

CAPT. SULLENBERGER: Yes. Again, the choice had to be made quickly because of the extreme time compression. By achieving Flaps 2, we had achieved almost all of the low speed stall protection that we would've gotten at Flaps 3, but at less drag. I was concerned about having enough total -- in the airplane to trade air speed for sink rate to cushion the touchdown. I chose 2 as a better option.

DR. WILSON: All right. Let's move on to the actual landing of the airplane. Can you describe your decision making process in terms of choosing a touchdown point on the river?

CAPT. SULLENBERGER: From my previous experience on layovers in New York, visiting the Intrepid Museum, I knew that there was an area of a lot of boat traffic in that part of the river. We're trained, in our ditching training, to try to land near vessels to facilitate rescue.

DR. WILSON: What role did crew resource management and Threat and Error Management play in the accident sequence?

CAPT. SULLENBERGER: It was an integral part of this scenario. We didn't have time to consult all the written guidance, we didn't have time to complete the appropriate checklist, so Jeff Skiles and I had to work almost intuitively in

a very close-knit fashion, without having a chance to verbalize every decision, every part of the situation. By observing each other's actions and hearing our transmissions and our reports to others, we were able to quickly be on the same page, know what needed to be done and begin to do it.

DR. WILSON: In our next Topic 2, we're going to be talking about the ECAM and ECAM exceptions and use of the QRH. How would you describe the usefulness and complexity of determining the appropriate procedure to follow, given that you have these multiple resources available to you?

CAPT. SULLENBERGER: Well, obviously, ideally it would be desirable not to have ECAM exceptions, but in this particular case, it was sufficient because they're listed in a quick reference handbook on the back cover.

DR. WILSON: Could you please describe what training you received at US Airways that you felt was most useful to helping you manage this event?

CAPT. SULLENBERGER: Well, we go through annual recurrent training, CQT, under our AQP program, that involves a day of classroom and two days in the flight simulator. We review many scenarios, we practice CRM, and I think all those things helped quite a bit.

DR. WILSON: From your interviews, you mentioned that you helped the flight attendants with the removal of one of the life rafts. Could you describe what training you received in

terms of cabin preparation evacuation procedures?

CAPT. SULLENBERGER: Yes. In the classroom portion, we actually use some of these in a cabin mock-up, operate the doors, learn the locations of the emergency equipment, and that also was vital in this case.

DR. WILSON: What training or guidance have you received from US Airways for ditching without engines running?

CAPT. SULLENBERGER: We have -- I've been familiarized with the QRH, but the classroom training on ditching is all that we've gotten. We have not received flight simulator training on ditching. I don't believe that the simulators are capable of simulating that.

DR. WILSON: Is there any written guidance that you've received or is it only training in terms of classroom and simulator training that you've received?

CAPT. SULLENBERGER: There is general non-aircraft specific training in our flight operations manual.

DR. WILSON: We know, from the CVR and previous interviews, that no information was available regarding birds that were in that area of LaGuardia on the day of the accident, whether it be the ADDS, PIREPS or air traffic control, from your experience, what significance do bird warnings play in your awareness during and after takeoff?

CAPT. SULLENBERGER: In my experience, the warnings that we typically get are routine and general and not specific in

nature and therefore have limited usefulness.

DR. WILSON: Just a few more questions for you. Once you made the decision to land in the river, did you ever consider using a different checklist or moving to the ditching portion of the checklist?

CAPT. SULLENBERGER: No. And if I had, time would not have permitted it.

DR. WILSON: How do you think that your experience with over 20,000 hours as a pilot helped you during this experience?

CAPT. SULLENBERGER: I think that it allowed me to focus clearly on the highest priorities at every stage of the flight without having to constantly refer to written guidance.

DR. WILSON: Looking back at the accident event, is there anything that you would do differently if you were faced with that situation again?

CAPT. SULLENBERGER: I think what we did, the situation we faced and the time that we had, First Officer Jeff Skiles and Flight Attendants Donna Dent, Sheila Dail and Doreen Welsh did the very best we could and I am proud to have been a member of a highly experience, highly trained team.

DR. WILSON: What lessons do you think that we can learn from this accident?

CAPT. SULLENBERGER: I think it's the importance of CRM, the importance of a dedicated, well-experience, highly-trained crew that can overcome substantial odds and working together as a

team can bring about a good outcome.

DR. WILSON: And one last question for you. Is there anything else that you would like to discuss today that we have not asked you so far?

CAPT. SULLENBERGER: Just to reiterate my gratitude for such a good outcome on January 15th and the amazingly quick response of the first responders from New York and New Jersey.

DR. WILSON: Great. Thank you. We have one more question for you.

MR. MARCOU: Thank you, Katherine.

Nicolas Marcou from the BEA, could you please explain to us how you ditch through the air speed when you try to do this emergency landing?

CAPT. SULLENBERGER: Yes. As we were not configured for landing, we didn't have a reference speed displayed on the PFD that we could fly, so I chose to use a margin above VLS.

MR. MARCOU: Thank you, Captain.

DR. WILSON: Thank you, Captain Sullenberger. Mr. Chairman, we have no more questions at this time.

CHAIRMAN SUMWALT: Thank you, Dr. Wilson. We'll now turn to the parties and the way we will work this is we will go to the parties in turn. We typically give the parties -- USAPA, Captain Sullenberger is represented by you and he is also an employee of US Airways, so what we do is we will allow the party whose witness it is to have the option of going last, so I'll ask

USAPA what is your preference?

CAPT. SICCHIO: Yes, Mr. Chairman. We would like to go last, if possible.

CHAIRMAN SUMWALT: You might have to fight that out with US Airways. But, US Airways, would you like to go in turn or would you like to go toward the end, as well?

MR. MORELL: We'll be happy to go second-to-last.

CHAIRMAN SUMWALT: Second to the last, thank you.

So we will start with the Association of Flight Attendants and what we will do is the parties have already heard this, but we will do 10-minute rounds. I'd like for the parties to police themselves in terms of watching the clock for 10 minutes. If needed, we can go for a second round, but we want to sort of keep the questions going. So we'll begin with the AFA. Thank you.

PARTY QUESTIONS

MS. KOLANDER: Thank you, Mr. Chairman.

Captain Sullenberger, what was the emergency command that you gave over the PA prior to impact?

CAPT. SULLENBERGER: I said this is the captain, brace for impact.

MS. KOLANDER: Was there any other announcement made by you over the PA prior to the water impact?

CAPT. SULLENBERGER: No, there was not.

MS. KOLANDER: Were you aware that the flight

attendants, based on your announcement, actually thought that they were going to impact land?

CAPT. SULLENBERGER: I have learned that subsequently, yes.

MS. KOLANDER: Thank you. As a previous instructor and a union accident investigator, do you think a better command to convey the type of impact information to enhance appropriate preparation might be brace for water impact?

CAPT. SULLENBERGER: I tend to think that I wish I'd had more time to more fully apprise the flight attendants of the situation that we faced. I probably spent some amount of time -- I would guess I had maybe four or five seconds to decide to make the announcement and what I should say and I chose my words carefully. My highest priority, at that moment, was to avoid passenger impact injury.

I didn't know at that moment how successful I would be in trading air speed for sink rate to cushion the touchdown, so my immediate concern, my highest priority, had to be to avoid passenger injury at landing, so I chose the word impact and brace to indicate that they needed to brace themselves to avoid impact injury.

I knew that the flight attendants would do their assessment prior to opening the doors and I wish I could've told them there was a water landing, but had I done that, they might've begun getting people to put on life vests and not being in the

brace position at impact, so it was a balancing act for the situation that we faced and the time that we had available.

MS. KOLANDER: Thank you. On Page 2 of your flight crew statement interview done on January 17th, you stated that you hopped into the 1 L door raft, but that you sat on the edge because you described the raft as full. Do you know approximately how many people were in the slide raft when you entered the slide raft?

CAPT. SULLENBERGER: I do not know. I attempted to find out as soon as I exited the airplane. I tried to get a count, passenger count, to account for one in the airplane. I did that in two ways. I tried to have passengers count off within the raft and I also shouted to a male passenger who was standing on the left in-board forward portion of the wing for him to take charge of the wing. I told him it was his job to get a head count on that wing by counting off. But those two processes were never completed because the rescue transpired before they could be done.

MS. KOLANDER: Okay, thank you.

CAPT. SULLENBERGER: I also was not able at all to communicate with those on the right side of the airplane because the fuselage was in the way.

MS. KOLANDER: Okay. Just so you know, the actual number, according to the NTSB survival factors report, indicates that there were 32 occupants per raft and those 32 occupants you said you considered as full. Have you, as a captain, ever seen

any pictures or received any training on what a slide raft at full capacity would actually look like?

CAPT. SULLENBERGER: I think I do recall having seen something in our recurrent training about that. I do not recall the number.

MS. KOLANDER: Would that be a recent recurrent training or one some time ago, considering your years of experience?

CAPT. SULLENBERGER: I can't remember which year it was.

MS. KOLANDER: Okay. Do you know or would you happen to know the certificated occupant capacity rating for the A320 slide raft?

CAPT. SULLENBERGER: I do not recall.

MS. KOLANDER: Okay. The actual answer is, according to the documentation, the capacity is 44 with an overload capacity rating of 55.

Now, under actual emergency conditions, do you think it is realistic that we can expect to get 44 occupants or 55 occupants in a slide raft when the NTSB report said that there were only 32 occupants in a raft that you described as full?

CAPT. SULLENBERGER: I think it would've been problematic, and I think the other issue that must be considered is that this was a relatively calm river. It was not the open ocean with a significant sea state.

MS. KOLANDER: Now, the survival factors report estimates that the first boat arrived to the aircraft

approximately four minutes after the first exits were opened. There's multiple passenger statements in the survival factors report that mention that they were very cold and that due to the cold, they had difficulty climbing into the rescue crafts when they arrived. Would you agree that this is a correct assessment of the conditions at the time?

CAPT. SULLENBERGER: Yes.

MS. KOLANDER: Despite the fact that the raft with 32 people appeared full to you, if you could have fit 55 people in each of the two available rafts, then only 110 of the 155 occupants onboard that aircraft could've been accommodated in the rafts. Where do you think the additional 45 people would have ended up?

CAPT. SULLENBERGER: I think that they would've ended up where they ended up or they would've had to remain inside the forward fuselage awaiting rescue of those in the rafts for them to move outward.

MS. KOLANDER: Okay. Taking the scenario a little bit further, assuming that rescue had not arrived prior to the aircraft submerging, where do you think these additional 45 people would have ended up?

CAPT. SULLENBERGER: I would hesitate to speculate any further.

MS. KOLANDER: Okay. Let's assume -- I'll do a little speculation, I guess, that if they weren't able to stay on the

wings, that they actually might have ended up in the water. How long do you think, taking into consideration how cold it was out there, that passengers not accommodated in slide rafts would have been able to survive in cold water that you were experiencing if rescue boats had not been very close?

CHAIRMAN SUMWALT: Are you an expert in survivability in water?

CAPT. SULLENBERGER: Member Sumwalt, the answer is no.

CHAIRMAN SUMWALT: Okay. We'll defer that question.

MS. KOLANDER: Okay. After this accident, what are your thoughts regarding the importance of rafts and/or slide rafts being available and usable for all occupants onboard an aircraft?

CAPT. SULLENBERGER: They're critical. We had the luxury of having an over water airplane, an EOW airplane. Many airplanes in the domestic fleet are not. We had slide rafts. We had life vests under each seat. Many aircraft have only seat cushions for floatation. I think consideration needs to be given to not all the exits being usable and therefore some of the slide rafts not being available.

MS. KOLANDER: Thank you, Captain Sullenberger.

Chairman, we have no further questions.

CHAIRMAN SUMWALT: Thank you, Ms. Kolander.

FAA?

MR. HARRIS: Good morning, Captain Sullenberger.

CAPT. SULLENBERGER: Good morning.

MR. HARRIS: You mentioned in some of your answers to Dr. Wilson's questions the importance of training and experience in supporting the actions that you took during the flight on January 15th. Could you describe, in more specifics, the kind of training that you received that supported these operations?

CAPT. SULLENBERGER: Well, starting in the late '80s and more in the early '90s, this airline has devoted a great time and effort to crew resource management. In fact, I was involved in some of the course development and some of the initial implementation. I was a facilitator and taught the course to hundreds of our pilots. It's something that's been deeply ingrained in this pilot group and flight attendant group and we have done, over the years, joint training in handling just these kinds of situations.

MR. HARRIS: How does the US Airways captain's authority portion of the flight operations manual play in to the actions on this particular flight?

CAPT. SULLENBERGER: Well, captain's authority or autonomy, the ability to make independent judgments within the framework of a professional center is critical to aviation safety and it's codified in our flight operations manual that the captain is ultimately responsible and the final authority to all matters of flight and the buck stops here. And so, we have the independent ability to make the right choice, do the right thing, every time despite the occasional production pressures.

MR. HARRIS: And if my memory serves me correctly, that statement in the flight operations manual starts with some discussion of it's impossible to write a procedure for every type of emergency, you're expected to use your judgment based upon your training and experience. Is that a rough summary?

CAPT. SULLENBERGER: That's a fair assessment, yes.

MR. HARRIS: Thank you very much. We have no further questions, sir.

CHAIRMAN SUMWALT: Thank you, Mr. Harris.

Airbus?

CAPT. CANTO: Good morning, Captain Sullenberger. But all of our questions have been answered by Captain Sullenberger put forward by the Technical Panel and by the other party members. Thank you, sir.

CAPT. SULLENBERGER: Thank you.

CHAIRMAN SUMWALT: Thank you, Captain. We'll go to CFM International.

MR. MILLS: Thank you, Mr. Sullenberger. Mr. Chairman, we have no questions at this time. Thank you.

CHAIRMAN SUMWALT: Thank you.

US Airways?

MR. MORELL: Mr. Chairman, US Airways has no questions at this time.

CHAIRMAN SUMWALT: Thank you.

USAPA?

CAPT. SICCHIO: Yes. Thank you, Mr. Chairman. Captain Sullenberger, good morning.

CAPT. SULLENBERGER: Good morning.

CAPT. SICCHIO: Thank you for your testimony this morning. Just a couple of questions for you.

Would you be kind enough to describe your background in CRM for us?

CAPT. SULLENBERGER: Yes. As I stated, I was selected to be among a couple of dozen pilots to be a course developer of our initial one-day introductory seminar. We helped implement that course and I was a facilitator for several years as we taught all our pilots the initial introductory phase.

And then, in the follow-on Phase 2, where we did recurrent training in our annual classroom training, I was also a facilitator.

CAPT. SICCHIO: Thank you. And in fact, Captain Sullenberger, did you actually participate as a group that brought CRM to the airline in the very beginning?

CAPT. SULLENBERGER: Yes. I think I may have actually taught the very first CRM course in a beta mode in our training facility in San Diego in the late '80s. We adapted a course that was used by the U.S. Air Force within the Military Airlift Command and we brought it to the airline and convinced the Airline Pilots Association Safety Committee it was a good thing. And then, we began, along with others, to convince our management that it was

the way we should go.

CAPT. SICCHIO: Great, thanks. So basically, you were in on the very ground floor development of CRM, is that --

CAPT. SULLENBERGER: Yes. And several others -- Captain Tom Hull (ph.), First Officer Chris Nicholas, and others, yes.

CAPT. SICCHIO: Okay. Throughout that experience, you've been able to assess the effectiveness of CRM?

CAPT. SULLENBERGER: Yes.

CAPT. SICCHIO: And would you mind describing the use of CRM on your flight that day and particularly how the rest of the crew responded and if you have any overall assessment of the effectiveness?

CAPT. SULLENBERGER: Well, first of all, it helped that I was flying with First Officer Jeff Skiles, a gentleman who's been at the airline for 23 years. Like me, he has 20,000 hours of flying experience. He'd been a captain at the airline before the cutbacks. For someone so new on the airplane -- had he not told me he was new to the Airbus I would not have known it because his skill levels were so high.

The flight attendants also were highly experienced, 30 plus years each. But we worked together as a team, we had a crew briefing at the beginning of the trip on Monday, January 12th, where we aligned our goals, we talked about a few specifics and set the tone and opened our channels of communication, so we functioned very well the entire time.

CAPT. SICCHIO: Okay, thank you. If you don't mind, I'd like to move to the post-landing portion of the flight. Could you describe for me, after you landed in the water, you entered the passenger cabin to assist with the evacuation. What did you find at that point? Were things orderly or could you describe the scene for us a little bit?

CAPT. SULLENBERGER: Well, while First Officer Skiles was finishing his portion of the evacuation checklist, I opened the cockpit door and I commanded the evacuation by saying evacuate and the evacuation seemed to proceed expeditiously and orderly. I didn't hear any yelling, people were moving quickly, but there did not seem to be any panic. I think it's largely a result of the flight attendant crew being so professional and exhibiting an outward calm and professional demeanor, the passengers responded in kind and behaved very well.

CAPT. SICCHIO: Okay. Could you also describe, once you left the aircraft, did you see an impending rescue once you exited the aircraft?

CAPT. SULLENBERGER: Actually, as soon as I left the airplane, there were boats already around us beginning the rescue.

CAPT. SICCHIO: Okay. And that being the case, we're well aware of the number of people located on the wings and those passengers, in your opinion, could they see the rescue boats approaching, as well?

CAPT. SULLENBERGER: I would assume that the people on

the wings could have seen them much before I could have.

CAPT. SICCHIO: Okay. And do you feel that that may have contributed to the overall calm nature of the -- not only evacuation but also the state of the passengers waiting for rescue on the wings?

CAPT. SULLENBERGER: Yes, they gave them help.

CAPT. SICCHIO: Okay, thank you. And I have no further questions. Once again, thank you for your testimony.

CHAIRMAN SUMWALT: Thank you, Captain Sicchio. Are there any follow-up questions from the parties?

(No response.)

CHAIRMAN SUMWALT: Technical Panel?

(No response.)

CHAIRMAN SUMWALT: Okay, we now turn to the Board of Inquiry. Dr. Kolly?

BOARD OF INQUIRY QUESTIONS

DR. KOLLY: Good morning, Captain.

CAPT. SULLENBERGER: Good morning, Doctor.

DR. KOLLY: You mentioned that you did not have any simulator training with regard to a forced water landing. Do you think such training would be beneficial?

CAPT. SULLENBERGER: Yes.

DR. KOLLY: And can you explain how? What, in the training, would you like to see, what do you think would help the situation?

CAPT. SULLENBERGER: I think, specifically, to control the flight paths, entry into the water, having engines out, emergency landing, forced landing, and of course, if it occurs necessarily at a higher rate of descent.

DR. KOLLY: During the landing, the accident landing, were you surprised by any handling of the aircraft or how that landing went?

CAPT. SULLENBERGER: No. Although, immediately after the aircraft stopped, a second reflection before we began the evacuation duties, First Officer Jeff Skiles and I turned to each other and almost, in unison, at the same time with the same words, said to each other, well, that wasn't as bad as I thought. So the entry to the water didn't seem bad from our perspective.

DR. KOLLY: Thank you. No further questions.

CHAIRMAN SUMWALT: Mr. DeLisi?

MR. DeLISI: Thank you. Thank you, Captain Sullenberger. Captain, when you're learning to fly a single engine airplane, you're almost always taught to be evaluating the ground beneath you to look for a suitable landing site. When you're flying a transport category airplane, does that thought enter your mind at low altitude?

CAPT. SULLENBERGER: No, although I would say that each of us has a general awareness of our position and our situation. That's part of the profession. We develop this mental model of our reality and the things around us, and so I think it was that

overall awareness that helped in this particular situation, so from experience, I knew the general layout of the metropolitan area. I knew which runways were available to us and where they were, in general terms.

MR. DeLISI: From the low altitude that you had to work with, if you envision yourself at many other cities that you fly in and out of, would a water landing likely be one of your best options?

CAPT. SULLENBERGER: It's so situation-dependent and there are so many variables. Each city is unique. Just looking at a map, you can see the terrain, the location of the airports, major bays and water. Each one is different.

MR. DeLISI: Were you aware that this airplane was equipped for extended over-water operation?

CAPT. SULLENBERGER: Yes, it's clearly stated on the cover of the aircraft maintenance log book.

MR. DeLISI: Did that factor in to your decision at all?

CAPT. SULLENBERGER: It certainly helped. But, as I said, we chose the only viable option we had and it just happened that we were well equipped for it.

MR. DeLISI: In your flying career, have you ever hit birds before?

CAPT. SULLENBERGER: Yes.

MR. DeLISI: Can you talk about what those experiences might've been like?

CAPT. SULLENBERGER: They've been minor. Often, there's no aircraft damage at all. We have the airplane inspected, we write it up in the maintenance log book and they sign it off and we're on our way.

MR. DeLISI: As you saw this flock of birds cross your wind screen, did you have any sense of the size of these birds?

CAPT. SULLENBERGER: Yes. There were many birds, they were very large, and they filled the entire the wind screen.

MR. DeLISI: Were you at all surprised that both engines were taken out by impacts when you encountered this flock of birds?

CAPT. SULLENBERGER: Yes.

MR. DeLISI: As you thought about putting the airplane down on the water, in your mind, were you envisioning that passengers would evacuate out onto the wings?

CAPT. SULLENBERGER: I didn't have that specific expectation. I had hoped that all the exits would be usable.

MR. DeLISI: As you actually did touch down, were you attempting to arrest the sink rate?

CAPT. SULLENBERGER: Yes.

MR. DeLISI: Were you surprised at the authority that you had available to you to arrest sink rate?

CAPT. SULLENBERGER: No, it seemed about what I expected. The aircraft, in every way, seemed to respond fully to my flight control input.

MR. DeLISI: I've had occasion to talk to some pilots who've landed out at Edwards Air Force Base on the dry lake bed, so essentially, a five-mile long runway. I want to ask you about your impression of the visual that you had in the cockpit now landing on a river that was miles wide and long. Did that affect your depth perception at all at touchdown?

CAPT. SULLENBERGER: Well, it certainly makes it a bit more difficult, in the definition. The fact that it was a more uniform surface makes it necessarily more difficult, also.

MR. DeLISI: Very good. Thank you very much.

CHAIRMAN SUMWALT: Captain Sullenberger, I've been at the Safety Board now almost three years and unfortunately, we don't usually have -- oftentimes don't have the flight crew to talk to. I appreciate your being here. Physically, I'm glad you're here so that we can ask questions.

CAPT. SULLENBERGER: Thank you.

CHAIRMAN SUMWALT: This event turned out differently than a lot of the situations the Board looks at. Tell me, in your mind, what made the critical difference in this event? How did this event turn out so well compared to, perhaps, other events that we see at the Safety Board?

CAPT. SULLENBERGER: I don't think it was one thing, I think it was many things that added up to a substantial whole. Again, we had a highly experienced, well-trained crew, and First Officer Jeff Skiles and I worked together well as a team and we

solved each problem as it presented itself to us.

CHAIRMAN SUMWALT: Thank you. I've wondered, in my mind, what your mindset is when you go to work. Some people are extremely focused. We saw a case of an accident that came before the Board a few weeks ago, a few months ago, where, while starting the engines, the captain said I'm ambivalent, I've got six months to go, referring to his retirement, and unfortunately, the performance of the flight crew, after they encountered an emergency, was less than stellar. What are the types of things that you think about when you're going to work?

CAPT. SULLENBERGER: Well, I think one of the many challenges of our profession is that it's become so ultra-safe where it's possible to go several calendar years without a single fatality, as we've just done recently, that it's sometimes easy to forget what's really at stake and sometimes, it may appear that we make it look too easy, that we assume it'll always go according to plan, it will continue to be as routine as it's been for years. So one of the challenges, I think, is to remain alert and vigilant and prepared, never knowing when or even if one might face some ultimate challenge.

CHAIRMAN SUMWALT: You testified to Congress -- you and I testified on the same day back in February, and you mentioned that the airline piloting profession faces some challenges. I want to make sure -- unfortunately, we, at the Board, we see events that don't have, oftentimes, good outcomes, so what can we

extract from your mindset, from the things you've learned, to basically hand over to others in your profession?

CAPT. SULLENBERGER: I think it's important, as we transition from one generation of pilots to the other, that we pass on some of the institutional knowledge. No matter how much technology is available, an airplane is still ultimately an airplane, the physics are the same, and basic skills may ultimately be required when either the automation fails or it's no longer appropriate to use it.

In addition to learning fundamental skills well, we need to learn the important lessons that have been paid for at such great cost over generations. We need to know about the -- accidents and what came out of each of them. In other words, we need to know not only what to do, but why we do it so that in the case where there's not time to consult every written guidance that we can set clear priorities and follow through and execute them well.

I think, also, it's important to note that nothing happens in isolation, that culture is important in every organization, and there must exist a culture, from the very top of the organization permeating throughout, that values safety in a way that it's congruent, that our words and our actions match and that people feel free to report safety deficiencies without fear of sanction. So all these things must happen together. We must balance accountability with safety.

CHAIRMAN SUMWALT: Thank you. In your mind, does US Airways have that culture of safety that you were referring to?

CAPT. SULLENBERGER: I think that they do and we're working very hard to make it what it needs to be every day.

CHAIRMAN SUMWALT: Thank you. I want to follow up on that by asking, in an interview that you had with the Safety Board, you stated, the question was, are there any external pressures from the company and you said, "I'm not sure." What did you mean by not being sure?

CAPT. SULLENBERGER: I think there are a few situations that can occur where a captain is questioned -- and again, we must balance accountability with safety. The captain's authority is a precious commodity that cannot be denigrated. It's the ability to do the job, it's the ability to maintain professional standards at the highest level no matter how inconvenient it may be, and so we have to work every day to make sure that's the case on every flight.

CHAIRMAN SUMWALT: Thank you. In looking at the CVR transcript and listening, actually, to the CVR, I noticed that you immediately, after both engines were lost, you immediately turned on the ignition; you fairly much immediately started the APU and then commanded for the loss of both engines checklist.

Oftentimes -- and we may even get some testimony on this later this morning or later today -- oftentimes, when somebody is faced with an unusual or surprising situation, there's a choke

factor, there's a startle response. You did not seem to exhibit that startle response. It was like you knew, you were prepared for this, you knew immediately what to do. What do you attribute that to?

CAPT. SULLENBERGER: Well, if you think I wasn't startled, you misunderstand. But I think both Jeff Skiles and I have done this long enough and trained long enough to have internalized the values of our profession and to have learned what needs to be done, and so we quickly acknowledged our bodies' innate physiological reactions, set it aside and began to work on the task at hand.

CHAIRMAN SUMWALT: And I think that is so important. I'm trying to get an idea of what your mindset is and how you were there. I can contrast you to a crew that we looked at recently that I mentioned the captain said he was ambivalent. They had an engine fire 800 feet AGL and it took about three and a half minutes before they completed the checklist, which should be a memory item, should be done immediately. So I want to be able to bottle your mindset and be able to make sure that everybody is drinking from that same bottle.

As far as the CRM, and the Threat and Error Management is concerned, what can we learn from your lessons regarding -- from CRM and Threat and Error Management?

CAPT. SULLENBERGER: I think that paying attention matters, having awareness constantly matters, continuing to build

that mental model to build the team matters.

CHAIRMAN SUMWALT: Thank you. Captain Sullenberger, I have no further questions. I want to thank you very much for your testimony, for being here this morning, and for representing the piloting profession as you do. You are excused from the witness stand. Thank you very much. You may get up and --

CAPT. SULLENBERGER: Thank you, Member Sumwalt.

CHAIRMAN SUMWALT: Thank you. While he is leaving, we will take a break. I know it takes a long time to get everyone in and out of the restrooms and all, so why don't we reconvene -- there's a clock right there. Let's reconvene at 10:25. We are in recess.

(Off the record.)

(On the record.)

CHAIRMAN SUMWALT: If I could have everyone take your seats, we'll begin in one minute.

HEARING OFFICER BENZON: And Mr. Campbell, please raise your right hand.

(Witness sworn.)

HEARING OFFICER BENZON: Please have a seat. And for the record, could you give us your name and occupation, please?

MR. CAMPBELL: Yes. I'm Billy Campbell. I'm the president and CEO of Panavision in Woodland Hills, California.

HEARING OFFICER BENZON: Thank you. Mr. Fedok?

TECHNICAL PANEL QUESTIONS

MR. FEDOK: Thank you, Mr. Benzon. And good morning, Mr. Campbell.

MR. CAMPBELL: Good morning.

MR. FEDOK: Thank you for being here with us today. Can you just begin by telling us where you were seated on Flight 1549?

MR. CAMPBELL: I was in Seat 25A.

MR. FEDOK: And that is the window seat on the second-to-last row in the cabin?

MR. CAMPBELL: Yes, sir, on the left side.

MR. FEDOK: Okay. And, sir, are you a fairly frequent flyer?

MR. CAMPBELL: I am.

MR. FEDOK: Can you quantify for us any way, weekly or monthly basis?

MR. CAMPBELL: I'd say probably -- historically through my career, probably flying every other week or every third week.

MR. FEDOK: Thank you. And were you flying alone on this particular flight?

MR. CAMPBELL: I was.

MR. FEDOK: Thank you. I think it would be helpful -- we heard this morning, Captain Sullenberger, talk about what happened at the front part of the aircraft, and I think it would be helpful for the audience, and for myself, if you could go through your experience in the back part of the aircraft.

If you could, start even as early as the boarding

process, just walk us through your experience as you boarded the aircraft, took your seat, all the way through the flight and then again through the evacuation and eventually through your rescue. Thank you.

MR. CAMPBELL: Sure. Well, it was an interesting day, in that all morning -- and I'll start just before the boarding. I'd been in New York for meetings and it had been quite snowy and windy in the morning. And by the time that I -- I do remember vividly, as I think a lot of my fellow passengers I want to say hello to that are here today, probably remember a lot of things about that day that maybe were inconsequential, but you know, you remember every detail.

And so I remember getting to the airport and telling the driver that it suddenly cleared up. I said wow, has the storm sort of gone out and he said I guess it has. So I'm a little bit of an aviation buff, so I remember when I did board and get on, even as cold as it was, I think 19 or 20 degrees outside, I remember thinking boy, this is a great day to fly.

As we took off -- it was a normal takeoff, we were a little bit late taking off, but I think we took off probably around 3:25 and it was a normal takeoff, we were on normal ascent. I remember looking out the window to the left and seeing, you know, the beautiful New York skyline and I think I reached down probably, maybe 30 or 40 seconds later and picked up a newspaper and was reading the paper, probably, I think, about 90 seconds.

I actually kind of got to see your image this morning, so now I think I was about right in terms of 90 to 100 seconds after we had taken off, I did not know the altitude, but there was a large explosion and sitting on the left-hand side, I was able to see out the window and I quickly, like most of the passengers, was startled because the plane shuddered and the engine, the left engine, was on fire. I'd flown many flights and actually -- excuse me -- had a number of friends who are -- pilots so I'd flown a lot and I'd seen engines sparking and a little bit of flame coming out occasionally in other aircraft, but nothing like this.

But my best description of that engine was almost a bonfire, and it continued to flame like that pretty much until we were near impact on the river. But, as we climbed out, I think all of us were not only concerned because of the shudder and the noticeable deceleration. I did find that we continued to ascend a little bit but there was also a very distinctive smell of jet fuel and I think that all of us in the back were a little concerned that there might be a fire, also, inside.

I do remember, it was interesting, there was a passenger that did stand up immediately after we'd had this impact and tried to get something out of -- from the right side, out of the overhead compartments and my flight attendant in the back, Doreen Welsh, immediately came and pushed this woman back into her seat and instructed her not to stand up anymore and to buckle her

seatbelt and, you know, that was going to be that.

Doreen also made a statement that everything was going to be fine and for everyone to remain calm. And so probably we're now maybe 15, 20 seconds after this impact and I'm guessing, this is my recollection, we then start to bank, a very slow bank, to the left.

Again, it's extremely clear this afternoon, so I can see LaGuardia out of my left-hand side and my assumption is that we're going to get back, we're going to go back to LaGuardia and change planes. We continue to bank, I'm guessing, maybe, for 15 or 20 seconds, very controlled slow bank, and I do feel like we're still maintaining our air speed, but maybe a slight deceleration.

But all of a sudden, I do realize that, instead of continuing back, veering back to LaGuardia, we actually have straightened out and now we're approaching the Hudson River. And again, I go back to, I guess, being a little aviation geeky, but it then crosses my mind that the pilot is maybe protecting himself if something's wrong, by being over the river. I'm still hoping that we're either going to Teterboro or Newark or in my mind, I'm just beginning to wonder, as we're now descending a little bit, maybe there's something I missed on Ellis Island or some possible strip that I'm just unaware of, but I'm hoping that as we go down river maybe we'd get to Newark.

I probably realized we weren't going to go to Teterboro when we continued down the river. My timeline is probably a

little bit off, but I assume that we're continuing down the river. Probably for another 20 or 30 seconds, we do cross the bridge, which I notice that we're actually quite low, but I never think that we're, you know, in danger of hitting the bridge.

It's very clear that we are descending because the buildings are getting much closer. I'm starting to actually see boats on the river. We're continuing to decelerate a little bit and a very controlled gradual descent. Probably about, you know, now we're probably a minute later from when I think the impact occurred and Captain Sullenberger comes on and says brace for impact.

At that moment, I think that all of us in the cabin then realized, you know, we had a huge issue. I knew we were going to crash into the river because I was on the window. My flight attendant, Doreen, in the back, then immediately instructed, sort of controlled, you know, yelling at people to put their heads down, to brace, head between your knees and just continue to say brace as we got closer to impact. I made the decision, wisely or unwisely, that I would sort of brace and by that, I didn't understand the complete logic of having my head completely down because I assumed that the seat in front of me was going to come back into me and so I wanted to have my head up just a little bit.

And I also made the decision that I wanted to be looking out the window to know exactly when the plane was going to hit the water because I least remembered, from reading about auto

accidents, that the more relaxed you were, the better opportunity or better chance you had to possibly uninjured or less injured. So we continued a very controlled descent, it was controlled from the beginning, and we got closer and closer; boats became, you know, very close to us on the left-hand side.

And when we ended up impacting, I did feel, that as we got down to probably a couple hundred feet or a hundred feet, I'm not quite sure, but I did notice that Captain Sullenberger lifted the nose of the plane, so those of us in the rear took the impact first and it was -- I would concur with Doreen in that it was, at least in the back, it was violent. When we did hit, I almost felt like I was on a cruise ship because as I looked out the window, the plane submerged and it felt like almost looking out a porthole because we were underwater. We then sort of bounced, came up, skidded, and it all happened, obviously, very quickly, but what I did notice is that all of a sudden, suddenly, the plane started to tip to the right. I did not know that the left engine had sheared off, but that clearly makes sense because our weight distribution shifted to the right-hand side. As we shifted to the right, the plane sort of tilted this way.

I immediately -- I'm sure all of us did -- just kept thinking please, don't turn over, or one concern was that the right wing would catch and that we would probably catapult as I'd seen with that African flight. Very luckily, or maybe because of Captain Sullenberger's skill and timing with the air speed, the

plane -- I think the right wing allowed us to drag and so what started was a fishtail and we ended up sort of sliding in the right -- the back side of the plane started to slide to the right, which is obviously why we ended up sort of facing -- the plane facing toward Manhattan.

When we finally came to a stop, you know, sort of feeling the miracle of wow, survived this crash, immediately water was rushing in through my window. Very quickly, I talked to the two fellows sitting next to me in B and C, said let's go, let's go, we have to go to the back.

One comment to go back to -- when I realized when Captain Sullenberger had said brace for impact and I had about that 45 seconds to a minute time before we did hit the water, I realized that I was -- I felt a little unlucky to be sitting on the window so far back because I knew that I was about 12 or 13 rows from the wing and the ability to get out there, but I then quickly looked and realized the only shot I had was to go out the back behind the lavatory.

So as we came to a stop and the water was coming in, I very quickly, along with the guys next to me, we got up and I'd say six or seven of us in the back went to the rear immediately.

Water was coming in very quickly. I would say within, you know, it was kind of a progression, a normal progression, of water at your ankles, at your knees, at your waist, and then probably the water ended up about right here with me. I think

Doreen was probably even a little deeper because she was in the -- you know, a little bit farther in the back in the galley and also a little shorter than I. Water continued to rush in and I guess my biggest concern, along with everyone's back there, was how do we get out?

Doreen, within about 10 or 15 seconds -- and I could not see this, I was to the lavatory and with her in the back, but she very forcefully instructed all of us that you cannot go out the back, we cannot get the back door open, turn around and go to the front, you're going to have to go to the wing. And when we actually turned around, that was sort of the second or third bit of horror because, as I looked, there was almost no way out.

There was -- the aisle was completely jammed and people were, you know, obviously -- making their best to get to the wing or get to the front. I decided the only shot that I had was to actually go to the right side and to start climbing over the seats and so I went to Row 26 and started to climb over the seats and I like to consider myself a little athletic and I -- in a dry back, I would have been hurdling those seats. But the water was up to about here on the seat backs and so we couldn't get much traction.

There were one or two other people that I noticed trying to go in the inside that were climbing over the seats. I was able to pull myself over each seat, you know, kind of fall into the water and then regroup and grab the top and sort of pull myself back over. Did that all the way until I got up to, I think, Row

14 or 12 or wherever the wing is and the first time that I felt like maybe I might make it. And as it turned out, there was a woman and her child, a young child, that were trying to go and they were a little bit stuck in the window.

Someone was out on the wing trying to help them, so helped them for just a minute and then realized I had to go over to the left side. So then I went back over to the left side and that was the time where I really felt that things were good because it was completely clear and I could go out that left window, but unfortunately, the wing was completely full and so the other choice, if I make -- was if I went out on the left side, then I would've knocked a few people in the water or I would have had to jump in the water. I continued to climb up the left side of the seats and I think I probably got to Row 8, 7, something like that, and then Captain Sullenberger and Captain Skiles and probably a flight attendant in the front yelled at me and said come on up to the front. The aisle had pretty much cleared now and there wasn't any water in that part, so I was able to then get in the aisle and run up to the front and they said let's go out, you can go out on the raft on the left side, so I ended up being the last passenger to go out into that raft.

Probably within about 15 seconds, 20 seconds, Captain Sullenberger and Captain Skiles jumped in next to me. I then reached over and after maybe 10 seconds when I did realize it looked like we might be fine and grabbed Captain Sullenberger by

the arm and just told him thank you, you saved my life, you saved all of our lives, and as you saw, with his testimony, he very humbly just said to me you're welcome. One thing I did omit to tell you was that when I did hear brace for impact and I went through sort of a mental, you know, both emotional and personal and then survival instinct thoughts, I did reach under my seat and try to pull out my life vest.

I could not get it out. That is in no way accusatory of the airline because it could've just been me and I just couldn't get it and after about 10 seconds of trying, I just said the heck with it. When I got to the -- when we got to the front, the last part of the story was we were all in the raft and we were waiting. It was kind of interesting because we were now in the raft, the plane was continuing to sink a little bit, certainly toward the rear, and I think a lot of us in the raft had a little bit of a concern because we were still tethered to the aircraft and we had no knife to cut free. And, fortunately, within three or four minutes the ferry did come and the ferry threw us a knife that I think either Captain Sullenberger or Captain Skiles used to cut us free and we then drifted free.

We still weren't completely home free because the ferries came and the first ferry came to pick us up and we then instructed them to go to the wing on the left side because those people were still standing in the water. As the ferry moved over, they, I believe, had some sort of rope ladder that they used to

throw over -- my recollection was that it wasn't a hard ladder, a firm ladder -- and the first couple of people, I think, had been in the water and were struggling to sort of get up, so it took a little while for them to pull people up.

The crew of the ferry was very focused on helping those people get on board and what happened was that with the current flowing south and continuing to flow, I think, down toward the Statue of Liberty, the rear of the -- the stern of the ferry ended up being sort of being pushed into our raft, so for even after, you know, thinking that we were okay, all of a sudden we were worried that the raft was going to, you know, be turned over as the raft started to sort of be pushed up in the front and come back toward us. I think enough screaming at -- the pilot finally got his attention to the ferry and he quickly sort of threw it into reverse and backed away. That happened a couple times.

And finally, they were able to start taking people off of the wing. Another ferry came and very -- I think, in a very organized manner, got us off. We stayed out in the harbor probably for 20 or 30 minutes, as I'm sure they all sort of gathered and came up with a plan, and then my ferry ended up going in to the Manhattan side.

MR. FEDOK: Thank you very much. I just have a few follow-up questions for you. First of all, sir, were you injured at all?

MR. CAMPBELL: Yes, but -- you know, not really. I

mean, I had a bad bump on my head that my mother noticed; I didn't really notice. And then I actually -- I think the only thing that I noticed was -- both of my college room mates were surgeons and had immediately called me and, you know, wanted to make sure I was okay and said look, your adrenaline's kicked in so, you know, you're going to feel things differently in about, you know, 24 to 36 hours, and I think, probably for about a week -- and I've talked to some of my passenger friends -- every morning that I woke up I was -- you know, felt like maybe three-a-day football practices. It was pretty rugged. But, other than that, no.

MR. FEDOK: Do you know when you received your head contusion?

MR. CAMPBELL: Not really. My assumption was probably upon impact when I hit the seat in front of me.

MR. FEDOK: Okay, thank you. Prior to the takeoff, do you recall if the flight attendants performed the typical safety demonstration?

MR. CAMPBELL: I vaguely recall that they did that.

MR. FEDOK: Did you watch much of it?

MR. CAMPBELL: No.

MR. FEDOK: Can you just tell me why?

MR. CAMPBELL: I think that I've flown so many times and you know, probably Captain Sullenberger's comment earlier was a good one, which is I think we all assume that things are going to be fine and safe, and I've flown that flight from LaGuardia to

Charlotte, North Carolina a hundred times and it was a beautiful day.

MR. FEDOK: Along those same lines, did you ever have occasion to look at the safety information card in the seat pocket in front of you?

MR. CAMPBELL: No.

MR. FEDOK: And the same reason for that?

MR. CAMPBELL: I look at them all the time now.

MR. FEDOK: Thank you. You mentioned your brace position when Captain Sullenberger made the PA announcement to brace for impact. Did you know what that meant?

MR. CAMPBELL: Well, to literally answer your question, no. I mean, I wouldn't say that I was 100 percent positive. I've seen enough, probably like all of us, you know, movies or thought about it enough to -- and the flight attendant was very clear on put your head down and to, you know, use the term "brace," but I think probably there were a lot of us that aren't really clear on exactly the definition of that term.

MR. FEDOK: And you chose to assume a somewhat brace position, you mentioned.

MR. CAMPBELL: Yeah, I would say I was, you know, pretty braced in that I was down very low, but I wanted to make sure that I kept my head up so that I could actually not have my head completely down and also, I wanted to be able to see out of the window so that I could time the crash.

MR. FEDOK: And did you have your seatbelt on and tight?

MR. CAMPBELL: Very tight.

MR. FEDOK: Thank you. After the impact, I want to talk a little bit about the water that came into the cabin. Can you just -- I know you gave a very good explanation of it a few minutes ago. Can you walk us through again how quickly the water came in and how quickly it rose?

MR. CAMPBELL: It certainly rose, from my perception, and those of us in the back, very rapidly, to the point of I thought that either it was going to -- we were going to run out of room in the back of the cabin in terms of head room or my concern was that the plane was going to sink and we were going to be stuck in the back.

In terms of a timeline, I don't know, but it was -- it seemingly, to me, was methodical in that all of a sudden the water was coming in through the window. I did not know that there was a hole in the fuselage, that was something that came out later. And there's actually been, I think, a lot written in commentary that, you know, maybe I should confirm or sort of be clear on, which is I had no idea that anyone in the rear had tried to open the back door. That, to me, was something that I heard later.

The first time that I ever heard any confirmation of that, whatsoever, was about 10 days later in Charlotte, when there was a reunion amongst a lot of us and the flight attendants and Captain Sullenberger, when I was talking to Doreen and we sort of

had our personal reunion and she then -- that's the first time that she told me that a passenger had actually gone by her and tried to open the back door.

MR. FEDOK: Okay, let me try to give you one landmark for a timeline. Prior to actually getting out of your seat, do you recall how high the water was in the vicinity of your seat?

MR. CAMPBELL: I think it was probably a foot, two feet. Hard to tell because I really remembered was the water coming in through my window onto me and then, as we sort of -- I was sitting next to the window, so I had to wait for a split second or two for the two fellows next to me to get to the back and by the time that I probably got into the aisle, it was certainly -- I knew that the water was coming in, it was probably up to my calf.

MR. FEDOK: Okay, thank you. And you mentioned your first reaction was to go to the back. Why was that?

MR. CAMPBELL: Well, it was the closest and also, immediately, most people were trying to go to the front and I thought that that was the only chance that I really had to get out.

MR. FEDOK: But you never got back far enough to see the doors in the back?

MR. CAMPBELL: Well, I could see the door. I wasn't so focused on that. I was really focused much more on Doreen and her instruction and, you know, she -- I would just like to compliment her because she was nails. You know, she was courageous, she was

direct, she didn't hesitate to say turn around, you have to go to the front. She waited until all of us had gone to the front and she was --

MR. FEDOK: So you mentioned that you climbed over some seats to get into the cabin. Why did you do that? Was that something that you saw other doing, was that something you were instructed to do in any way?

MR. CAMPBELL: Well -- excuse me. I wasn't instructed to do that other than I was instructed to go to the front and when I turned and there was no way to get to the front other than to take that route, that was the only shot I had.

MR. FEDOK: And you mentioned you got all the way up to the over-wing exits and then had to cross over the aisle and that the wings were full and you couldn't exit that way, is that correct?

MR. CAMPBELL: That's correct.

MR. FEDOK: The one thing I did want to clarify with you, sir, is you mentioned you attempted to retrieve your life vest and that was after Captain Sullenberger's brace for impact command?

MR. CAMPBELL: Correct.

MR. FEDOK: And prior to the impact?

MR. CAMPBELL: Yes, sir.

MR. FEDOK: I apologize. I got that wrong in my interview summary. That's in my factual report and I will issue

an errata to clarify that. But can you just describe to me again what your -- what you attempted to do to get that vest out? You tried for about 10 seconds you said?

MR. CAMPBELL: Well, I just reached under. I didn't, you know, stoop down to look under there. I just reached under and was trying to pull it and it either seemed to be caught or I wasn't pulling it correctly.

MR. FEDOK: Thank you. When you got outside the aircraft and you were in the 1-L raft on the left side, did you have occasion to look back on to the left wing at all?

MR. CAMPBELL: Sure.

MR. FEDOK: And can you describe what you saw there?

MR. CAMPBELL: Well, my fellow passengers were lined up on the wing all the way out to the tip and were standing and you know, it appeared to me that they were standing in probably knee-deep water.

MR. FEDOK: And at what point did you remember seeing the first ferry?

MR. CAMPBELL: A ferry came from the, sort of the nose of the plane and came around and was coming in toward the front of our raft and that's when we instructed them -- and I'm guessing. Captain Sullenberger or someone said the timeline of three minutes. It seemed longer to me, but that was my recollection.

MR. FEDOK: And can you just describe the process of boarding from the raft to the vessel?

MR. CAMPBELL: Yeah, we -- it was a little difficult. It was a makeshift sort of ladder, more rope, so it took a little bit of strength. I know that one or two passengers that I had watched from the wing who I assume had been the water and quite cold, needed assistance to be able to get up there. I was able to pull myself up and climb up, but it wasn't an easy climb.

MR. FEDOK: Thank you. Mr. Chairman, I have no further questions.

CHAIRMAN SUMWALT: Thank you. No further questions from the Technical Panel at large?

(No response.)

CHAIRMAN SUMWALT: All right, we'll now turn to the parties and first up will be the Federal Aviation Administration.

PARTY QUESTIONS

MR. HARRIS: Good morning, Mr. Campbell. Thank you for your testimony today, sir.

MR. CAMPBELL: Where are you? Oh, great. Okay. I'm sorry.

MR. HARRIS: Out here.

MR. CAMPBELL: I couldn't see you.

MR. HARRIS: I'm sorry about that.

MR. CAMPBELL: That's okay.

MR. HARRIS: Good morning and thank you for your testimony today.

MR. CAMPBELL: You're welcome.

MR. HARRIS: You mentioned something about water coming in through your window in your discussion. Could you describe that in greater detail? Was the window actually compromised?

MR. CAMPBELL: I've thought about that. To the best of my knowledge, it wasn't cracked and it certainly hadn't come out. You know, I was just being a -- you know, amateur scientist. My assumption was that we had not pressurized and that it -- probably the seal was sort of, you know, compromised when we crashed, but I have no idea. I just know that it was coming in, you know, through the seams.

MR. HARRIS: Okay, thank you. And you did answer the question I was going to ask, which was related to your use of the -- of what you would do differently now as a passenger on -- as a frequent flyer flying many trips since then, I'm sure. And could you go into greater detail about your sense of -- your actions now as a passenger, let's just say that, your actions and attitudes as a passenger now riding on an airplane.

MR. CAMPBELL: Well, I'm extraordinarily attentive now to our flight attendants and I think that I'm probably very sensitive to exit locations. I always take a look at the -- you know, I watch them now very carefully in terms of the instruction, but also I do always pick up the -- you know, the seat back material, just to take a quick look. But I think most importantly, I focus on exactly where the exits are.

CHAIRMAN SUMWALT: Thank you very much. Mr. Chairman,

we have no further questions. Thank you, sir.

CHAIRMAN SUMWALT: Thank you. Airbus?

MR. CAMPBELL: Hi.

CAPT. CANTO: Mr. Campbell, good morning.

MR. CAMPBELL: Good morning.

MR. MORELL: One brief question. As you entered the life raft, did you feel that the life raft was fully occupied and there was no available space on the life raft?

MR. CAMPBELL: You know, it's a good question and I will give you two answers. I thought it was full, but I thought it could handle some more people.

MR. MORELL: Good, thank you.

MR. CAMPBELL: Sure.

CHAIRMAN SUMWALT: No additional questions? All right, US Airways.

MR. MORELL: Mr. Chairman, we have no questions at this time.

CHAIRMAN SUMWALT: Thank you. CFM International?

MR. MILLS: We have one question. Mr. Campbell, thank you for giving testimony and thank you, as well, for showing support to your fellow passengers during the flight.

The one question we have is on Engine Number 1, you reported that you saw flames coming out of the engine. Did you see those flames extinguish or did they continue throughout the landing?

MR. CAMPBELL: They continued throughout and I think that, if I had to, you know -- if I had to guess, I would say that, by the time that we impacted, you know, crashed, they probably diminished just a tad. But I -- my vivid memory is that it was -- and that's why I use the term bonfire. It was not flaming, it was burning.

MR. MILLS: Thank you. I have no further questions.

CHAIRMAN SUMWALT: Thank you. USAPA.

CAPT. SICCHIO: We have no questions, but Mr. Campbell, good morning and thank you very much for your testimony. We appreciate your interest in safety.

MR. CAMPBELL: Thank you.

CHAIRMAN SUMWALT: AFA.

MS. KOLANDER: Mr. Campbell, thank you very much and on behalf of the flight attendants, thank you for being more proactive now when you fly about paying attention to our safety demonstration. We do appreciate that. Mr. Chairman, we actually have no questions. Mr. Fedok was able to answer all of our issues.

CHAIRMAN SUMWALT: Thank you. And, based on the lack of questions, I assume there are no follow up from the Technical Panel -- or from the parties?

(No response.)

CHAIRMAN SUMWALT: And from the Technical Panel, follow up?

(No response.)

BOARD OF INQUIRY QUESTIONS

CHAIRMAN SUMWALT: Okay, we'll now go the Board of Inquiry. Dr. Kolly? Mr. DeLisi?

MR. DELISI: Thank you. And thank you, Mr. Campbell. Can you tell us how cold the water felt?

MR. CAMPBELL: Well, I think for me, personally, even though I was quite deep in the water, I never felt the temperature. I was so focused on other things. I do vaguely remember a little bit of a shock when the water came in, but I think that that was -- I would've been just as shocked if it had been 78. I think we all felt it the longer that we were outside, you know, I do remember when I first made a call to my family, you know, I could barely hold the phone and I could barely -- I was chattering, so it was quite cold.

MR. DELISI: And as you looked back towards the wings, did you see any passengers that slipped off the wings and were actually swimming in the water?

MR. CAMPBELL: No, I think that I got off so late. I've read these stories of a couple of people swimming and I just talked to a friend earlier who went swimming and was pulled into the raft, but no. It was actually quite tranquil once we had gotten out of the plane, you know, slowly floating down, seemingly everyone out and it seemed to be pretty much under control. I think the biggest fear we all had was how long would the plane

stay afloat.

MR. DELISI: And certainly now we understand that you ended up in the rafts, but perhaps in your conversations with other passengers, were you or any of the other passengers aware that the airplane was equipped with lifelines that could've provided a tether out onto the wing and a handhold for folks that might be out there?

MR. CAMPBELL: That's the first time I've heard that.

MR. DELISI: Okay. Thank you.

MR. CAMPBELL: Sure.

CHAIRMAN SUMWALT: Well, thank you very much for being here, Mr. Campbell. I wanted to get this straight. I had made a statement in the media over the weekend that you would testify to the fact that the flight attendant had gone back and opened the door and just for the record, would you like to comment on that statement? Because I have a feeling it's erroneous. You didn't testify to that, so let's clear it up what your testimony is, exactly.

MR. CAMPBELL: Well, my testimony is very consistent to what I said. I have had no conversations with anyone in the press in at least three months, so I was a little shocked to have read that story, as well. I had no idea that the door, the rear door, had been compromised at all. All I did was follow instructions from Doreen Welsh and all she had said was, you know, you can't go out the back, you know, you cannot go out this door, turn around

and go to the front. And she was very firm about that. And so the minute she said that, we all, you know, six or seven of us, I think, in the back, turned around and did our best to get to the front. Very fortunately, we were able to do it. The plane stayed afloat long enough for us to be able to do that.

CHAIRMAN SUMWALT: Thank you. So it is your testimony, to be very clear, that she did not open the aft door, is that correct?

MR. CAMPBELL: It is my testimony I did not see that and then that she did tell me later that a passenger had actually done that.

CHAIRMAN SUMWALT: I appreciate your clarification and I apologize to you for my getting to wrong and I also apologize for any angst that might've been caused to the flight attendant or others for that statement. Did you say that the water was actually coming in through the window?

MR. CAMPBELL: I did.

CHAIRMAN SUMWALT: Okay, thank you. I have no further questions. Hang on, stand by just for a second. We're trying to figure out when to take lunch. That's what all these important negotiations are about.

MR. CAMPBELL: If I could just say one last thing before I leave, I'd just like to thank, particularly -- and I do this on behalf of my fellow passengers who actually haven't given me the privilege of doing that, but I'll assume it. We are all so

thankful that this turned out the way that it did and all of us have different struggles with different things, whether it's waking up in the night or not being able to fly or not -- you know, we've all sort of formed a bond and people share a lot.

But I'd also really like to just say that we've seen -- and it's been very difficult for me -- people ask me what's the most difficult thing that I have to deal with and quite frankly, the most difficult thing, and I would assume many of us share this, is seeing the other flights that don't end this way. You know, I came home and -- about three weeks after this and saw on the news the Buffalo flight and then obviously, we were all terribly saddened by what's happened with Air France. I'm just a guy and I'm just a passenger, like all of us, fly every day and all I can say is that, you know, we were so fortunate that we had an unbelievable pilot, an unbelievable co-pilot, and three extremely talented, brave flight attendants, and I guess, as passengers, I try to make a habit every now -- every time, every flight -- you said something, sir, from the FAA, earlier about just paying attention. Not only do I do that, but each flight I try to stick my head in the cockpit and say thank you very much, so I just want to say, on behalf of all of us that, you know, if it weren't for that crew then, you know, you're right. We wouldn't be having this. I'm extremely appreciative.

CHAIRMAN SUMWALT: Well, thank you. And I'll say I've never walked out of this cockpit/voice recorder lab with a smile

on my face, but in this particular occasions, I -- it was an uplifting occasion to find out that the result was as positive as it was. Mr. Campbell, I want to thank you for your testimony. It's been very good. And we will -- it's a little early, but I think no one will object. We will take a lunch break. I'd like to start in one hour. We will reconvene at, according to that clock, at five after 12:00. We are in recess. Thank you.

(Whereupon, at 11:05 a.m., a lunch recess was taken.)

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

(Time Noted: 12:05 p.m.)

CHAIRMAN SUMWALT: Okay, we'll get started here in another minute.

(Pause.)

CHAIRMAN SUMWALT: Okay, we are back in session and Mr. Benzon, I will turn it over to you so you can call the next series of witnesses, please, sir.

HEARING OFFICER BENZON: Okay, the next group is a panel. The Board calls Captain Marc Parisis, Captain John Hope, Mr. John Duncan, and Dr. Barbara Burian to the stand, please. Would you raise your right hand?

(Witnesses sworn.)

HEARING OFFICER BENZON: Thank you. Please be seated. And Captain Parisis, we'll start with you. Could you give us your full name and occupation, please?

CAPT. PARISIS: My name is Marc Parisis. I am the Airbus Vice President, Flight Operations Support and Services. I am in charge of and accountable for all flight operation and documents by Airbus. I'm a pilot, qualified and current on Airbus aircraft. I'm a training captain, check airman. I'm also a test pilot. I've been in my current position for two years and my previous position was -- Airbus flight crew training.

HEARING OFFICER BENZON: Thank you. Captain Hope.

CAPT. HOPE: My name is Captain John Hope. I'm employed

by US Airways. I have an office in Phoenix at our Phoenix training facility and also one in Charlotte at our Charlotte training facility. I've been employed by US Airways since 1985. In 1998 I was asked to be the Senior Check Airman on the Airbus 320 program and in November of 2007, I became the fleet captain of the Airbus fleet at US Airways.

HEARING OFFICER BENZON: Thank you. Mr. Duncan.

MR. DUNCAN: Thank you, sir. My name is John Duncan. I'm the manager of the FAA Air Transportation Division. I've been with the FAA since 1986. I served in the field in a number of positions, including the division manager of the Alaskan Region. I've been in the General Aviation and Commercial Division as the manager and now I'm the manager of the Air Transportation Division.

HEARING OFFICER BENZON: And Dr. Burian.

DR. BURIAN: Good afternoon. I'm Dr. Barbara Burian. I'm a research psychologist. I work at the Human Systems Integration Division at NASA Ames Research Center and I used to lead the Emergency and Abnormal Situation Study that was conducted at NASA until 2005.

HEARING OFFICER BENZON: Okay, I'll turn you over to David Nelson (sic) and Katherine Wilson.

TECHNICAL PANEL QUESTIONS

CAPT. HELSON: And thank you all for joining us here. Good afternoon. We will start with Captain Parisis. We

understand you have a presentation to share with us?

PRESENTATION BY CAPT. PARISIS

CAPT. PARISIS: Correct. So if we can have the presentation on the screen, please? So in this short presentation, we will a summary of the operational documents provided by Airbus and the presentation of the abnormal emergency process for the development of this -- in this presentation, we will differentiate between a planned ditching with reasonable time to prepare the aircraft and passenger, and immediate emergency landing on water with limited or no time to prepare. At the design phase of a new aircraft, all procedure are developed considering the applicable regulation and the Airbus analysis of system failure consequences.

During the in-service time of the aircraft, procedures are revised as a result of new or changed regulation, like new -- aircraft design change installation of new system or modification on the current system; in-service experience, and that would be the case for the engine failure; operator feedback, when we have some operator feedback, that's a different -- it was difficult to go through some emergency procedure where we've revised them; and training feedback. One -- is the modification on the ground emergency evacuation following important training feedback that it was not so easy for the crew to go through this procedure. For this change, we go through formal process involving both the Airbus Flight Department and the Airbus

Training Department. We really believe that it is a very good mix to have both expertise of the flight test pilots and the training captain when we do a revision of procedures. We start with the documentation provided by Airbus. The Aircraft Flight Manual is specifically reviewed and approved by the Aviation Authority and once it is approved, all the other documents, whether it be from Airbus or the operators, must be consistent with the Aircraft Flight Manual.

We also provide ECAM. The ECAM is an electronic system that will be provide automatically the procedure on the cockpit screen with the all the action to be taken by the crew. If you have more than one procedure to be done, they will be characterized and set in the right order to be done. Airbus also provides reference documents such as the Quick Reference Handbook, is a paper printed documents setting all the correction in occurrence that will not be detected by the aircraft, so not displayed on the ECAM, on the screen.

We provide the Flight Crew Operating Manual with all the information in a more expanded way, and the Flight Crew Training Manual. This is not to be used in the cockpit. It's for use in training to understand the why and the how of the procedure, so it gives you more explanation when you have time to go through, during your training time. Each operator can and do modify the Quick Reference Handbook, the Flight Crew Operating Manual, and the Flight Crew Training Manual according to their respective

operation. And for sure, each operator is responsible to obtain the applicable approval from their own operational aviation authority. Now, let's see how to execute an abnormal and emergency procedure. First, we'll see, using the electronic checklist displayed on the screen in the cockpit, and then the ECAM. In most of the case, the aircraft can auto-detect the issue and will display the list of actions to be followed by the crew.

So in the read-and-do principle, the crew will read the action on the screen and execute the action. If the aircraft cannot auto-detect the situation, for example, in case of volcanic ash encounter, the ECAM will not display the procedure, of course. The crew then has to refer to the printed paper Quick Reference Handbook that is available to the crew in the cockpit. It will be also the case for the need to refer to the Quick Reference Handbook if we have a temporary revision of the procedure displayed on the ECAM and waiting for the update of this electronic device that could take some time, we'll issue a temporary procedure in the Quick Reference Handbook.

And we can quickly consult the procedure on the ECAM screen, so in this case, the ECAM will have only the title of the procedure with the wording "refer to Quick Reference Handbook." We also have some ECAM exception. This is a very specific case for which even if we have the correct procedure displayed on the ECAM cockpit screen, we command the crew to refer to the paper printed Quick Reference Handbook. This will be the case, for

example, for the smoke procedure and for the Dual Engine Failure. The reason for that is that the ECAM procedure on the screen will be long and have to be done in sequence. Using the paper checklist and taking into consideration the real situation of the aircraft, the crew will have the possibility to go directly to the appropriate chapter or section of the procedure, so we think that it will be more efficient for the crew to go to the printed paper procedure for these very few ECAM exceptions. Both the ECAM and the paper procedures are used according to the read-and-do principle.

So procedures must be applied without reference to any screen or paper. These are called memory items and they are related to situations requiring immediate action, so one example could be wind sheer or loss of braking during the landing run. So taking into consideration the human performance and -- we really try to have the minimum number as possible of memory item procedures. Now looking at the specific Engine Dual Failure procedure, this procedure has been designed for high altitude situations.

All required actions are displayed on the cockpit screen, the ECAM. However, it's a very long procedure and has to be done in sequences. The crew will also have to turn and cross reference to some other procedure. That's why we decide to make an ECAM exception of this procedure and that was for wing and emergency -- situation and so we recommend the crew to take this

procedure as an ECAM exception and to refer to the QRH, Quick Reference Handbook. So the ECAM exception, we authorize a very quick distinction between "Fuel Remaining" and "No Fuel Remaining" condition and this new paper procedure has been designed as a get-in/stay-in procedure with no further need to turn to other procedures. Now looking at the ditching procedure available in the paper Quick Reference Handbook. It has been designed assuming a planned ditching with engine thrust available and time to prepare the aircraft.

So one example could be a persisting cabin fire, leaving the cabin to -- the decision to plan for a ditching. So we have seen that Airbus provides the Aircraft Flight Manual with abnormal and emergency procedure that -- reviewed and approved by the Aviation Authorities. Airbus also provides reference documents to the operators. The operator may revise these reference documents and must obtain the approval from their operation aviation authority. Airbus, as it continues improvement process based on all this input on the screen and we continuously review and improve our procedures.

CAPT. HELSON: Captain Parisis, thank you. And a few follow-up questions for your presentation. I just want to clarify a few things you brought up regarding the ECAM and the ECAM exceptions. I noted you pointed out in some cases that use of the QRH is more efficient than using the ECAM. How do you determine that a procedure should be identified as an ECAM exception in the

first place?

CAPT. PARISIS: Yes. So we think that for some of them, like the -- low level procedure, we think that they should be an ECAM exception -- for some other case like the smoke procedure that has been determined for the -- review of the smoke procedure at the industry level. And for the one we are talking about, the Engine Dual Failure, it has been decided to make it an ECAM exception on -- following the list for emergency landing in 2012.

CAPT. HELSON: Okay, thank you. So it varies in each case. Also, you pointed out that in some cases, is due to a revision to an ECAM procedure. How often is the list of ECAM exceptions revised?

CAPT. PARISIS: We have only four in-flight ECAM exceptions today. It's revised only when needed, as I said, the l said, the latest one being this engine -- so this is very exception and we try to keep it as a minimum number as possible.

CAPT. HELSON: Okay, thank you. And moving on to the QRH Engine Dual Failure procedure, when developing the Engine Dual Failure procedure, what sources of information were consulted to determine the content of that procedure?

CAPT. PARISIS: Maybe we can use a backup slide. So this new procedure has been dispatched in 2005 and I have a backup slide if we can have on the screen that we'll explain the historical background. So following an emergency landing in a no fuel remaining situation, we decide to review the procedures, so

we have the different working groups with the flight operation, the flight test, the design office. We make some evaluation of different scenarios using simulators. We also work closely with the investigator of this accident. We also have a specific interview with the pilots that have been involved in this event and we come out with that's the best way we determine an ECAM exception with two different scenarios, fuel remaining/no fuel remaining. We have the evaluation of this scenario in the simulators with both training captain and flight test pilot, and we propose the mitigation to the authority and that has been satisfied by the authority. So that was available for -- presented as it arrived to the customer in 2004 in various conferences and it was finally implemented in 2005.

CAPT. HELSON: Okay. And also, when developing the Engine Dual Failure procedure, what consideration was given to an event occurring at low altitude with limited time available?

CAPT. PARISIS: Well, actually, at this time we developed a procedure to cover the most probably scenario, so based on aviation worldwide experience, it was engine failure due to no fuel remaining situation or due to -- conditions such as volcanic ash -- so we did not consider the very low altitude or engine failure.

CAPT. HELSON: Okay. Moving on to the procedure itself includes a section -- Mr. Smith, if we could bring up Exhibit 2(j), Page 5, that's Page 7 in the PDF document, please. Okay,

this is an excerpt from the Engine Dual Failure procedure in the Airbus Quick Reference Handbook. Do you agree?

CAPT. PARISIS: Yes.

CAPT. HELSON: And this is the section particularly that pertains to ditching. Now, in this section, there's a note -- if you follow down the page to below the 2000 foot AGL, there are two steps following that box, about halfway down the page, and then there's a note following the ditching pushbutton step. This note basically describes 11 degrees of pitch in minimum aircraft vertical speed should be used. What is the process for determining the guidance that is provided to flight crews in these written procedures?

CAPT. PARISIS: So we provide the extended information in the flight crew operating manuals, so you will have maybe something like -- pitch on the -- information about how to ditch and we find out the right balance between the length of the information and the time needed to read it and what we will select to be in the Quick Reference Handbook, so this is done by expert, both the flight test and training captain.

CAPT. HELSON: Okay. And how was this evaluated, this guidance, how was it evaluated to determine it was operationally feasible?

CAPT. PARISIS: So we ran different scenario in the simulators with line pilots after -- evaluation by the -- process.

CAPT. HELSON: Okay. And during that evaluation

process, did you determine is a pilot expected to fly a normal approach profile to achieve this condition at touchdown or is there a different specific recommended procedure to accomplish that?

CAPT. PARISIS: We do not have any very specific procedure related to the Airbus aircraft. This is non-type specific, so we do not conduct the simulation down to the ditching, itself. We stop the evaluation when we are close to the surface because the simulator is not -- to go further.

CAPT. HELSON: Okay. And on this same page, just a little higher up, the procedure -- or excuse me, the step to determine the approach, there's a note there and a box to aid in determining the -- approach speed for a specific weight. How do you -- the speeds calculated here compared to the speeds that would be used for an approach when engine thrust was available?

CAPT. PARISIS: So if you have the engine thrust available and you plan for a ditching, correct?

CAPT. HELSON: Correct.

CAPT. PARISIS: So in this case, we have another -- that requires different setting of slat and flaps, so you would use a different speed because your configuration would be different. So we decided to put this table in this Quick Reference Handbook to avoid to jump to other part of the printed checklist, so as I said before, it's a -- concept.

CAPT. HELSON: Okay. I have a question for you on

another exhibit, 2(cc). Mr. Smith, would you bring that up, please? That's perfect right there, thank you. I draw your attention to the paragraph that begins with the number one and I'll read something briefly to you. It says, "If no power is available, a greater than normal approach speed should be used down to the flare." This is an excerpt from the Federal Aviation Administration's Aeronautical Information Manual and what I'm curious to know is if are you aware of any similar guidance available in Airbus manuals or training programs?

CAPT. PARISIS: Not directly referring to that. We provide directly the appropriate speed to the front. I assume that this is also what we, as pilots, learn during initial training when we use to practice no thrust landing situation on the -- aircraft and as I said, this is nothing specific to the Airbus aircraft.

CAPT. HELSON: Okay, thank you. And moving on to another area, could you tell us what guidance does Airbus provide the pilots regarding bird strike hazard awareness and how are pilots made aware of that information, please?

CAPT. PARISIS: Yes. So we issue documents and the one I show you that is the flight operation briefing notes, this is all documents that are available for everybody in terms of safety awareness reference. They are available on the website, airbus.com, so they are not limited to the Airbus pilot. So we have a specific eight pages document, it's part of the -- of the

next panel, about the bird strike. Know on -- how SOP. We have a procedure requesting to set all the light on the -- before takeoff to diminish the risk of bird strike and all the other information being not type specific. I'm not directly in the flight -- manual, so it's more the flight operation --

CAPT. HELSON: Okay, thank you. A few minutes ago, you discussed with us the process for -- that Airbus goes through to revise a procedure and I think you touched on that there has been a review initiated as a result of this accident. Would you describe for us how far along you are in that process and what you have learned so far?

CAPT. PARISIS: So we are at the very beginning step of this process and it's for sure it will be too early to have the outputs now. We are also still looking for -- defect. We are thinking about the necessity -- to issue specific memory items procedure covering this type of situation. Decision is not -- we are in the review process.

CAPT. HELSON: Okay, thank you. Captain Hope, I understand that you also have a presentation to share with us.

PRESENTATION BY CAPT. HOPE

CAPT. HOPE: That's correct. I must first point out that this is a US Airways Airbus training program that's going to be presented today. I've been asked to briefly describe the training and guidance in two areas, Dual Engine Failure and ditching procedures at US Airways. In general, though, US Airways

provides pilot training in a number of areas: recurrent classroom, ground school-type classrooms that include training devices, full-motion simulator, computer distant learning on the Internet, and operating experience in aircraft. The US Airways Dual Engine Failure training is consistent to the manufacturer's training from Airbus. US Airways provides Dual Engine Failure training in all qualification training on Airbus. Dual Engine Failure, as I said, is trained in the initial qualification footprint in Lesson 6.

The objectives are to recognize the Dual Engine Failure and the subsequent relight-type procedures. What you're looking at here in front of you is a virtual simulator. It's a virtual A320 simulator. It is used in our briefing prior to full flight simulator. We use snapshots that create different learning objectives and the learning objective of Dual Engine Failure we could go through. It includes all the ECAM and also any sort of navigation database, so we can basically fly the airplane in the briefing room on this virtual simulator.

In reference to the Dual Engine Failure objective, we look at the recognition, we look at the aircraft control, checklist usage, and the engine restart procedures as we look also at the emergency electrical configuration in this objective. The simulator session. What you're looking at right there is one of many US Airways' simulators. The scenario -- which we use a lot of scenario-type training at US Airways. The scenario for Dual Engine Failure checklist starts out at 25,000 feet at -- excuse

me -- 300 knots and we focus, again, like I said, on the recognition and it is very consistent to exactly what Airbus trains in this Dual Engine Failure. We look at the proper use of the ECAM exception and we also go through the procedures in the QRH. We try at a wind-milling start for our pilots, so they go through that first and then we get the APU started and we do a starter assist. There's a lot of talk about ECAM exceptions. As Airbus mentioned, the Dual Engine Failure checklist is an ECAM exception. One of the enhancements that US Airways has done is to try not to memorize these ECAM exceptions. There are a number of reasons why you can have an ECAM exception and first let me start to say that the ECAM, itself, is a wonderful for electronic checklist and electronic non-normal checklist. But there are occasions when the paper is better. And it was mentioned in smoke; you may not be able to see your displays in ECAM, so you'd want to go to your QRH, your Quick Reference Handbook, where the font size is much larger due to the fact that the cockpit may be filling up with smoke.

Second reason, also, we look at the Dual Engine Failure checklist for a number of different reasons, as mentioned. We could -- we take, as a human, we put judgment into the ECAM by looking to see do we have fuel or no fuel at all, so at high altitude with volcanic ash. So we look at the methodologies and as we mentioned here, on the back of our Quick Reference Handbook is a list of the ECAM exceptions, and in this particular case, the

Engine Dual Failure checklist is located on Page 27 and the pilot would very simply go to Page 27 and be right on the Dual Engine Failure checklist from the Quick Reference Handbook. When we look at the QRH, Quick Reference Handbook, procedures, once again, as I said, we determine the fuel status, we look at the optimum relight speed, the attempted restart procedures, and if we have to, we look at the -- if we cannot get an engine started, we'll look at the landing strategy.

One of the things that we heard from Captain Sullenberger was the use of CRM and Threat and Error Management. Threat and Error Management is used in the Dual Engine Failure checklist in this particular spot in the simulator. We're assessing the situation, we're balancing those barriers. In other words, we're using the proper use of the Quick Reference Handbook and we're communicating effectively while using all of the standard operating procedures at US Airways. As I said, there is a lot of talk about Threat and Error Management. We feel one of the best things about the outcome of this accident was the crew's use of Threat and Error Management at US Airways.

Yes, they were taught at high altitude the Dual Engine Failure checklist, but by reviewing the skills and going through the skill set in the simulator and by using Threat and Error Management properly, they were able to use those skill sets at lower altitude for the outcome that was presented today. Let me take a little bit of time to discuss our Threat and Error

Management model. What you're seeing in front of you is a graphic depiction of our Threat and Error Management philosophy. It is a tool that is used in all of our training material and on all of our references. We use it, this type of posters, in all of our training facilities, in all of our briefing rooms. We also evaluate our crews in scenario-based type training and evaluating using the Threat and Error Management model. Threat and Error Management and CRM have been embedded into the US Air training curricula and line operations since early 1991.

It's been into the year 2000 that we needed to look at this pilot error a little deeper. Simply looking at the three parts of Threat and Error Management, let's first look at the green, yellow, and red target or symbol, if you will. A pilot, like our pilots in 1549, started at -- and we heard how such a nice day it was, was in the green. We train and evaluate our pilots and take them out into the red, which is pretty much what we've heard what was described by not only our passengers, but the flight deck, and that is they were instantaneously put out into the red by loss of Dual Engine Failure.

The colored icon that we talk about -- and we talk about going from the green all the way out to the red. In training and evaluating, we'll show our crews scenarios that take them to the yellow. May not always take them out to the red, but the key is how do they get themselves back into that green or very close to it. We use barriers. Barriers is what you're seeing up here, is

policies, procedures, flows, checklist, automation, external resources, and of course, the knowledge, skill in aircraft handling. Each pilot has a set of these barriers that they employ. When we talk of the word barrier, what we're saying is -- and then throughout the Threat and Error Management model, we have to say that pilots are humans and they make errors. How can we trap and mitigate those errors? We do that by erecting these barriers as high as possible, each pilot.

By erecting these type of barriers as high as we can, okay, we can trap and mitigate those errors. And the last part there is the ABCs of Threat and Error Management. Actively monitor and assess the potential for error. Picture yourself driving into a busy intersection in your car and you're saying there could be some errors here in this intersection. Balancing the barriers that are available, okay, to avoid and trap errors, like I said, part of the B. More importantly, communication, effectively and timely communication.

And of course, always following the standard operating procedures of the airline. I'd like to shift my presentation today towards ditching. Ditching training is covered in ground school for the initial students on Day 1 and for all pilots in distant learning over the Internet. It's divided into two phases: the preparation phase, which talks about communication and procedures, and also the approach phase that adds additional procedures closer to the ground and also the approach phase

below 2,000 feet. What you're seeing here in front of you is an excerpt from our distant learning. Distant learning on the Internet provides not only an audible wording as we step through the procedures in the QRH, but also the pilot is able to read, as you see on the bottom of the screen, all of the audio that is presented to them in distant learning. I'd like to just finish up by showing you, off to the left, at US Airways, in ground school we gain the knowledge of systems, but also procedures in the Integrated Procedural Trainer that you're seeing off to the left. We use this without motion so we gain the knowledge and procedural skill prior to full flight motion, which is off to the right in one of our US Airways simulators. Thank you.

CAPT. HELSON: Thank you for your presentation, Captain Hope. We do have a few follow-up questions for you. First of all, regarding the QRH and ECAM exceptions, how does US Airways identify the need for inclusion of a particular procedure in the QRH?

CAPT. HOPE: We mimic Airbus. We get Telex or an FCOM or a QRH revision and we go through each and every one of them to determine and if need be, we'll discuss them with Airbus.

CAPT. HELSON: Okay. We heard from Captain Parisis a few minutes ago discussing the rationale for recommending the Engine Dual Failure as an ECAM exception. Do you at US Airways agree with that assessment?

CAPT. HOPE: We do. We follow the manufacturer.

CAPT. HELSON: All right. And while your procedures and checklists are based on the manufacturer, I can't help but noticing that they are slightly different formatting-wise and that US Airways does develop their own checklist, correct?

CAPT. HOPE: That is correct. We operate Boeing aircraft and Embry Air aircraft and Airbus aircraft. Our pilots go between these different types of manufacturers, so we feel the need to make our checklist as easy as possible for our pilots to be able to reach the material. You need the pilot handbook, which all of those formats are correct or the same, and the QRH. Now, again, the QRH format is -- we utilize all the tools in the industry to build the best QRH we can for our pilots. We are different than Airbus in the sense of the squares and the dots that they have on their QRH because we use a lot of step procedures or the OR (ph.) statement.

CAPT. HELSON: Okay. And also I noticed -- now, Captain Parisis stated that right now there were four ECAM exceptions that Airbus had identified, but I noted on your ECAM exception page there were six. Do you also identify additional ECAM exceptions?

CAPT. HOPE: We do. We operate a number, over 200 single aisle Airbus aircraft. We look at the early aircraft that we received from Airbus and the latest ones that we get from Airbus just last week and we determine, through operating engineering bulletins, what needs in our fleet to still be an ECAM exception.

CAPT. HELSON: Okay. Now, moving on to the dual engine failure training and procedures, in your presentation you indicated that the dual engine failure training was consistent with that of the manufacturer. What is the rationale for conducting that training at high altitude?

CAPT. HOPE: Well, we follow the manufacturer in the sense that they do it at high altitude for the same reason that was presented already and that is the accidents that have existed or the incidents have existed at high altitude with loss of engine due to either fuel starvation or volcanic ash. Where we are different with Airbus is they start their scenario at 35,000 feet and we start ours at 25,000 feet at 300 knots, but the same objectives are still fulfilled. We still try the different engine start procedures, whether it's wind-milling or starter assist, and we both get one engine started.

CAPT. HELSON: Okay. Now, moving on to the ditching training provided by US Airways, in your presentation you stated that ditching training was covered in ground school and also in distance learning modules. Could you tell us what ditching scenarios are not included in the simulator curriculum and what would be the benefits and risks of including them?

CAPT. HOPE: I can. For years and as long as I've been associated with a number of different operators that we've operated at US Airways as far as manufacturers, we've never taken our training and ditching into the simulators. We've always used

classroom or distant learning to get our procedures across. There is a number of different reasons, but we look at -- we do a risk assessment, we look at the data, and then we really look at the data as far as touching down on water, per se. There really isn't that much for us to draw from. When we look at the fidelity of the simulators, as was pointed out, the loss of time for a simulator, when a simulator lands on anything else but asphalt, could be very timely and costly to the airline of loss of simulator time.

CAPT. HELSON: Okay, thank you. And a review of the US Airways training program in previous interviews indicated that ditching training focuses mainly on ditching with engine power available. Does US Airways provide any additional guidance for ditching without engine power available?

CAPT. HOPE: You are correct that we use ditching with power because that's the way Airbus teaches their ditching module with aircraft power, but in our training manual, we do make reference, the same reference that you made mention to in the airmen's information manual, in our training manual for our pilots.

CAPT. HELSON: Okay, thank you. And that training manual, is that information from the training manual, is that included in the training curriculum, the ditching curriculum?

CAPT. HOPE: No, because the training that we look at is procedural based and it's done with power, as we say, as I just

mentioned, and we rely on our pilots to be familiar with what's in the training manual.

CAPT. HELSON: Okay. That was going to be my next question. So a pilot is responsible for being familiar with the information in that manual?

CAPT. HOPE: That is correct.

CAPT. HELSON: Okay. Now, in the development of procedures for the QRH, how do you determine if any information from company manuals should be included in the QRH procedure?

CAPT. HOPE: Well, very easily, we have a Director of Flight Tech Publications. We go through an extensive review of all of our procedures across our fleets. We'll look at not only manufacturer changes or revisions, but we also look at different types of data that comes in to the airline, whether it's given to us by our pilots or whether it's given to us by our aircraft in our Flight Operations Quality Assurance Program.

All of these data points coming in to the different fleets and the fleet looks at procedures from the manufacturer, it looks at issues that are going on to its particular airline, in this case US Air. We do, on the Airbus and I know on the Boeing and Embry Air at US Airways, they do a lot of testing in the simulator and a lot of these recommendations are brought up to our Flight Operations Standards Board. We show them the background of why we think some of these should change and we look for their direction.

CAPT. HELSON: All right. I understand, also, that US Airways conducts training under the Advance Qualification Program. How long have you been doing that?

CAPT. HOPE: We've been doing that since -- I know on Airbus we've been doing it since 2004, the Airbus and other fleets were brought in to AQP. In 2000, I think it is, or '99 or 2000, we started with one fleet into the Advance Qualification Program and that was the 737 fleet.

CAPT. HELSON: Okay, thank you. Could you tell us how the training under AQP is different than the conventional training, what are the advantages, disadvantages?

CAPT. HOPE: Certainly. Under AQP is -- or the Advance Qualification Program, it's an ever-changing, ever -- quality assurance training program. We look at the proficiency of our pilots and the operation of our airline and we make recommendations to the -- our air program managers or our FOSB groups, our Flight Operations Standards Board, in things that we need to change.

It's an ever improving training program. Compared to a list of maneuvers that we used to do that was dated way back when and we just continue to add to those maneuvers, and the difference here, meaning we've also taken into the AQP program more of scenario-based training versus just the maneuvers. And also the other thing that we do under AQP is bring in, once again, our Threat and Error Management to go along with our scenario-based

type training. And our scenario-based training lends itself very well to the Threat and Error Management model and we evaluate our crews utilizing the Threat and Error Management model.

CAPT. HELSON: Okay, thank you. Now, in regards to bird strike hazards, what training or guidance does US Airways provide the pilots regarding bird strike hazards?

CAPT. HOPE: Bird strike hazards are embedded into our normal operating procedures at US Airways. For example, lights on from takeoff all the way through 10,000 feet and once again, descending down from 10,000 feet to the ground. Also, in our takeoff briefings or departure -- approach briefings, when we look at any other risks or intentions for obstacles and that would come to our pilots in the form of the ADDS or ATC letting us know about birds.

CAPT. HELSON: Okay, thank you. Now, you touched on this earlier with the AQP, but I was wondering if you could expand a little bit and possibly give us an example or two of how US Airways uses information from previous accidents and incidents and company data collection programs in the development of your training scenarios?

CAPT. HOPE: Absolutely. We had 49 incidents in the world on Airbus aircraft that had a malfunction to the AC Bus 1 faults and of the 49 incidents, two of them happened at US Airways. We took the five recommendations that came from this Safety Board and we implemented them onto our training and

procedures. As an immediate action item, it was added to the Airbus 320 fleet as a loss of captains PFD, ND, and Upper ECAM, Primary Flight Display, Navigation Display and Upper ECAM Display. We also adjusted our simulators to give the proper malfunction and we incorporated that into this year's recurrent training not only in the briefing, but also in the simulator.

CAPT. HELSON: Okay. One final question for you, Captain Hope. What changes in training or procedures have occurred at US Airways as a result of this accident?

CAPT. HOPE: At the present time, we are evaluating our data and going through our risk assessment of what happened and took place. One of the things that we're very pleased with is how the crew -- and they mentioned how much Threat and Error Management works so well for them, and we'd like to continue with that, which we will, of course, as we look to the manufacturers to see what procedures and what the industry will do with this type of an accident.

CAPT. HELSON: Okay. Thank you, Captain Hope, for your time. I appreciate it. Mr. Duncan, good afternoon. I wonder if you could start out for us by describing the duties and responsibilities of your current position at the FAA?

MR. DUNCAN: Yes, sir. I manage the Air Transportation Policy Division. We're responsible for regulations, policy and guidance for air carriers under Part 121, Part 135, and also flight training facilities under Part 142.

CAPT. HELSON: Okay. Can you briefly describe for us the process for evaluation approval of flight operations procedures and training programs for a US air carrier?

MR. DUNCAN: Training programs are submitted by the air carrier. That may be submitted at the air carrier's initiative or -- because the FAA's asked for something. Those are submitted to us. We evaluate, we do an initial evaluation to determine that the training program meets the standards, it also meets the manufacturer's guidance, it's consistent with the manufacturer's guidance, consistent with guidance from Flight Standardization Board and then after evaluating that, we will give initial approval of that program. On initial approval, we will then monitor -- after initial approval, we will monitor the carrier's application of that program and after we have sufficiently monitored the program, we'll give final approval.

CAPT. HELSON: Okay, thank you. Is the process different for evaluating abnormal and emergency procedures versus normal company procedures?

MR. DUNCAN: No, sir. We're looking for the same sorts of things. We're looking for consistency with manufacturers' recommendations, consistency within the air carrier, as Captain Hope described, from aircraft to aircraft, those consistencies in procedures and those kinds of things.

CAPT. HELSON: And during that evaluation process, how do you determine what information from company manuals or

additional source material might need to be or should be included in an emergency procedure that would be contained in the QRH, for example?

MR. DUNCAN: We will look at the procedures that are provided to us and we're looking at general consistency of those procedures and we have folks who have expertise in that area who are looking to see that those procedures flow, that there's enough information there to get the job done, to accomplish the task that's supposed to accomplished, and the appropriate guidance available.

CAPT. HELSON: Okay. Now, I brought up a few exhibits earlier for Captain Parisis and Captain Hope. One was from an excerpt from US Airways training manual, the other from the FAA's Aeronautical Information Manual. Are these documents normally included in that review process?

MR. DUNCAN: Certainly, all that guidance is considered whenever we're reviewing a training program. We're looking at guidance that the manufacturer has produced, the guidance that we have, and making sure that the procedures are, for our purposes are effective and will be effective in the long term.

CAPT. HELSON: Okay. Thank you, Mr. Duncan. Dr. Wilson?

DR. WILSON: Great, thank you. Good afternoon, Dr. Burian. Thank you for being here. Before we get on with your presentation, could you please describe your relevant background

and experience regarding emergency and abnormal events?

DR. BURIAN: Sure. Under the previous aviation safety program that was led at NASA that ended in 2005, I led the Emergency and Abnormal Situation Study and this was a multi-year -- actually, a set of studies that was designed to take a look at how flight crews are prepared for and then respond to and manage emergency and abnormal situations that occur on the flight deck. In addition to that work, I chaired an international symposium on emergency and abnormal situations that was held, sponsored by NASA in 2003, and over the last nine years, I've been able to collaborate and consult with a large number of air carriers and aircraft manufacturers; accident investigation bodies such as the NTSB and others; regulatory bodies; military; aviation groups, units regarding how we train flight crews to deal with emergency and abnormal situations; human performance and capabilities and limitations under high stress and high workload, and particularly regarding the design of emergency and abnormal checklists that flight crews use to respond to these events, both paper-based and also electronic checklist systems.

DR. WILSON: Great, thank you. I know that you have a short presentation prepared for us, so if you'd like to proceed with that.

PRESENTATION BY DR. BURIAN

DR. BURIAN: Okay. So I mentioned the emergency and abnormal situation study. This was really very broad. It was

meant to take a look at a wide range of issues in how flight crews respond to situations and so you can see, on this chart, a number of the different areas that we were interested in really taking a look at. Today I'm really just going to focus on sort of three different areas. The first is checklists and procedures; also talk a little bit about training and human performance. Now, when we began this study, we started by taking a look at sort of educating ourselves and one way to do that was to take a look at incident and accident data.

We conducted a study of the incident reports that had been filed by flight crews during a one-year period who had indicated that they had dealt with an emergency or an abnormal situation. These incident reports were filed with the Aviation Safety Reporting System that NASA runs and we found 107 reports that were filed and we ended up dividing them into sort of two major categories, and one category we called the textbook emergencies and the other were non-textbook emergencies.

And a textbook emergency is an emergency that can be anticipated by a manufacturer when they're designing an aircraft and so they develop procedures for responding to that particular situation. They are situations that are typically highly trained once flight crews go through their training at the air carriers, and then the emergency, itself, unfolds in a way that is very similar to the kind of training that the flight crews experience during training and the checklists are designed very well for the

exact way that the situation unfolds. So that's kind of a textbook emergency. Of course, then non-textbook emergencies are all those other kinds of situations. So out of the 107 incident reports that we looked at, 22 of those were textbook emergency or abnormal situations and you can see that the vast majority of those were handled quite well. Unfortunately, most of the events that we took a look at were non-textbook emergency situations and the vast majority of those were not handled well, meaning that there was some problem with either the way the flight crew or other people responded to the event or there were problems with the materials and resources that the crews had to use, and these were reported in the narrative sections of these incident reports.

So in addition to looking at the incident and accident data, we've also, in the emergency and abnormal situation study, we also gathered information in a large number of other ways. We spent a lot of time analyzing checklists and procedures, both paper and electronic. We've worked quite a bit with people who have manufactured, developed, these checklists and procedures.

We've talked to manufacturers, we've talked to a lot of people at airlines, we've interviewed pilots who've been involved in emergencies and some are accident pilots. And so through all of these different data sources, we were able to gather kind of a really nice picture of a lot of the different issues that are going on and it was from that list of issues that we actually came up with the previous chart sort of describing the different areas

that we felt we needed to focus on in this work. What I'm going to spend the rest of my time here in this formal part of the presentation is just giving you a very quick high-level overview of some of the issues, some of the specific problems that we discovered through all these different sources of information and some of the fixes that we have identified as possibilities in the areas of training and also checklist design. So in terms of some of the problems with response, one sort of general cluster had to do with the way that crews respond to the situations and some of these are not a problem with the crew, per se; it has to do with something that affected their ability to respond effectively.

So for example, it was quite common for us to find that air crew did actually not know the exact situation that they were dealing with, so in contrast to the accident that we're here meeting about today where the crew was very clear at very beginning exactly what their situation was, what their malfunction was, and how they were supposed to go about responding, a lot of times the cues that crews see are quite ambiguous, not very clear, or they come to the crews in kind of piecemeal fashion so it can be very difficult to put together a real coherent picture of what it is that they're dealing with.

Many times we found that crews were not trained adequately or the training that they received didn't really help prepare them to respond to the wide variety of those kinds of situations that they were dealing with. Now, when we are -- as

humans, when we are dealing with high stress and high workload that sort of typifies these kinds of situations, our motor skills are pretty robust, they're not really affected very much by the stress, which is great. But unfortunately, our cognitive skills are highly affected, highly vulnerable, during these kinds of situations, so it can be quite easy for crews to become quite task saturated and as a result, have a lot of difficulty with cognitive processing, difficulty prioritizing what they should be doing and also, what we call strategic shedding of tasks.

So when workload becomes very high, you have to start dropping off things but because you're so overloaded mentally, oftentimes it can be quite difficult to figure out which tasks you want to drop and which ones you really want to focus on. It's harder to sort of step back from the situation and sort of mentally evaluate that. Fixation, tunneling, these are often very common kinds of things that we see, as well, in terms of how flight crews respond to the situation. I mentioned that sometimes we've identified that there are problems with how other respond.

An example of that was that in one incident report that was filed with the ASRS system, a crew reported that they had declared an emergency and were actually completing a diversion to an alternate airport and air traffic control asked them to do a 360 to create a little space for some other traffic that was coming in. So here there was clearly, you know, a problem with communication and the air traffic controller's understanding of

the severity of the situation that the crew was dealing with. And then, of course, we found often a lot of problems with some of the materials and resources. Many times, the checklists have either been not appropriate for the situation, they were designed with one kind of situation in mind and the actual conditions that the crew was having to deal with were quite different and didn't match up, so the steps didn't really quite fit with what they were having to sort of respond to or in some occasions, checklists didn't exist at all for some of the situations.

Crews often reported having difficulty finding the proper checklist or if you remember I mentioned the ambiguous and incomplete cues, oftentimes it was difficult for them to sort of determine if they were in the right checklist and sometimes found themselves completing steps that were actually inappropriate and then having to shift and move to a different checklist.

So there was some discussion about some design issues, things that were confusing, and as Captain Parisis talked about, that many times crews are sometimes required to jump from one checklist to another, and this might be between or among multiple emergency and abnormal checklists, but it also might be then to jumping to normal checklists or to performance charts and tables or the MEL or a variety of other materials and resources, so that some of these checklists and procedures have a pretty high memory demand, a high cognitive load, that they present to the crews. We also found that some checklists were quite long and that some

critical items either didn't appear at all. For example, the suggestion to the crew to consider a diversion in the case of in-flight smoke, fire and fumes, we found a number of checklists that didn't mention anything about that. Or the critical items that crews might need to complete appear very late in the checklist and so when the workload is so high, it's a possibility that the crews might never ever get to those particular steps. In terms of some fixes, I'll start with training.

One of the things that we identified when we observed quite a bit of training was that crews were oftentimes presented with these textbook scenarios and so the procedure always worked as intended, the light always went out in the simulator, there was always plenty of time to complete the entire procedure, and the cues were always quite clear, and so oftentimes the crews were not faced with that kind of ambiguity that you often see in real life. And so one of the suggestions we have is to increase the realism of the training, make it so the procedure doesn't always work, that there's not enough time to complete the procedure.

And also, we think it's important that crews really be, as much as possible, faced with the same kind of workload in the simulator sessions as they are in real lift. So we observed a number of times instructors sort of minimizing some of the work so the crew would say, You know, we're practicing smoke, fire and fumes, but do we really have to put the mask on? No, you can leave it off. So they never had to really practice with the mask

on or with the goggles on and get used to what it's like to try to communicate with all this stuff on your face and to be able to see things in the cockpit. They often gave either really abbreviated briefings or just said well, at this point I would brief the flight attendants or I would make a radio call and they've never actually had to -- you know, were forced to go through the actual -- all those steps. So we think that that's important, to make -- or that the crews really have an opportunity to practice under the same kind of situations that they might really encounter in real life.

Another option would be for people to rethink a little bit about the scenario and training philosophy, again, getting away from that textbook approach and really sort of come up with some scenarios that don't really have a clear cut response or don't have an exact checklist to be used. And I want to acknowledge that there are a number of air carriers that we are aware of that are starting to be quite creative in doing some of the very things that I'm talking about, but there are still enough out there that could really sort of benefit from thinking about some of these other opportunities.

Also, combined training we think is also of great value, where you have people from multiple different groups, the flight crews, cabin crews, air traffic control, maintenance or dispatch, kind of involved together, working through a common scenario and getting the opportunity to really sort of see how that might

unfold and how they might work together. In terms of fixes regarding checklists and procedures, we've identified, my colleagues and I, 14 different factors that pertain to the design and content of emergency and abnormal checklists, and so this is oftentimes the place to start, which is making sure that these 14 factors have been adequately addressed as you're working through your design. And I can talk more about some of these factors later, if you're interested.

But that's really only the first place to start and oftentimes when I'm consulting with folks on their checklists, they will start here but they're usually only focused on one or two factors that they're particularly concerned about; typically, do we have all the proper steps in the checklist for the crew or will this be clear to the crew, those kinds of questions, so a number of factors get missed. And also, something that's often missed is sort of an understanding or thinking through about how these checklists actually have to get used in the operational context.

So you have to think of all the other operational demands that are going on at the same time that influence how a crew is going to respond and you also have to think about the human performance capabilities and limitations under high stress and high workload, and that, in particular, is something that gets missed. And so these two extra circles, the context and also the human performance considerations should influence a lot of the

checklist design and content features of those 14 factors, how we actually design these checklists. So to be a little bit more specific in terms of some fixes with checklists and procedures, one problem that is often described as the difficulties crews have in actually finding the proper checklist, and there's a number of ways that we can help facilitate that, both paper, with paper checklists and also electronic checklists. Captain Parisis talked about the get in/stay in philosophy.

This has been a great advantage and US Airways was actually one of the first US air carriers that I'm aware of who actually adopted this philosophy in the development of their checklists. A number of other air carriers have adopted that, as well; other manufacturers, too. It really helps to cut down with the confusion in the workload and having to find all these other multiple resources because you can just have one-stop shopping. I think it's important to consider the full range of situations for a which a checklist is supposed to be used.

So for example, levels of severity. We've seen a number of checklists for pressurization problems that are written for the most extreme sort of pressurization problem, a rapid depressurization, but they don't work very well for pressurization problems at the lower end of the continuum, things like a slow leak, for example. So you really need to think about the full range of situations, where that checklist is going to need to be used to make sure it really has the greatest utility possible.

Obviously, you need to think about where and when the situation might occur, both geographically but also in terms of different altitudes, you need to consider different types of weather conditions, terrain, oceans, all those kinds of things. And also, I talked about some of the context, so this is some of the other operational tasks and operational demands that have to be completed concurrently because sometimes when these checklists have been developed, when you look at them, it appears almost as though folks thought that the checklist was the only thing people were going to have to be doing on the flight deck, that they could just run that checklist and there weren't going to be all these other operational tasks.

You still have to fly the plane, you have to make decisions, what am I going to do, am I going to land, where, you have to talk to ATC, coordinate the flight attendants, so there's all these things going on. That was illustrated so beautifully this morning.

So you really have to think about that when you're putting together the checklist and you have to make sure that your validation of the checklist includes an assessment of the workload of not only completing the checklist, but also all of these other operational tasks and demands. And part of that assessment of workload has to include an assessment of the timing length, not just the physical length, how many pages or how many steps is the checklist, but also how long does it take to complete them, how

long does it take to complete those steps on the checklist but also as you're integrating and inter-leading all these other operational tasks and demands. I think it's important to build in, particularly for situations that might be highly time critical, what we call gates or opt-out points in checklists and these are places were crews are invited to sort of step back, because it's so easy, when you're under this high-stress/high-workload, to get so tunneled in to your situation and what you're working on that you can sort of lose track of some of the other stuff that's going on and other things that you need to be doing at the same time.

So these gates or opt-out points are places where you tell the crew, you know, evaluate your situation, step back for a second, evaluate it, and should you be doing something else now, should you drop this checklist and focus on, for example, preparing the cockpit -- you know, the aircraft for landing or ditching.

But when you put together these gates and opt-out points, you also have to consider the location of critical items relative to them, so you want to make sure that these critical items, if there are any in a particular checklist, don't occur after the gate or opt-out point, so you make sure that those particular steps occur earlier in the checklist before you get to that opt-out spot. And then finally -- and this, of course, is something that I feel pretty passionate about, being a human

factors researcher, is that we really have to look at the human performance capabilities and limitations when we put together these checklists and really reduce, as much as possible, the cognitive processing load that we place on our pilots when they're dealing with these high-stress and high-workload situations.

DR. WILSON: Great. Thank you so much. We have a few follow-up questions to your presentation. First, I'd like to start out with you outlined a number of problems with crew response to an emergency or abnormal event and one of the things that stuck out in my mind with Captain Sullenberger's testimony was that he said paying attention matters in these situations. From your experience, what impact do these sort of problems have on a pilot's decision making process?

DR. BURIAN: The effect that it has on the decision making process typically shows up in that crews get very focused. I talked about tunneling or fixation. You sort of have difficulty shifting your attention among multiple cues or multiple things in the cockpit and you get kind of sucked in on one or two or a few things, and so when you're trying to make a decision about something, you need to be able to actively process information in working memory. You need to be able to take information in and think through what you're faced with and decide then, you know, kind of what your best options are. I talked a minute ago about difficulty in prioritizing. Working memory is that part of our memory where we actively process information. We hold it in

there, we take information in, it's how we decide what we're dealing with, and it's also what we use when we're trying to make a decision. And unfortunately, under high stress and high workload, our working memory actually shrinks and so the amount of the information we can hold in working memory becomes smaller and the amount of time that information stays in working memory also reduces, so it's kind of a double whammy, if you will. So all of these things come together to really create quite a few challenges for crews in terms of their cognitive processing and decision making.

DR. WILSON: You also discussed in your presentation -- you had that nice chart of the ASRS data that you evaluated and from my quick math it looked about that 85 percent or so of textbook emergencies were handled well by crews versus less than 10 percent of non-textbook emergencies. We understand that pilots can't be trained for all possible scenarios, but in lieu of that, is there something that we can do with training, are there generalize-able skills that we can train pilots to be able to handle these non-textbook emergencies?

DR. BURIAN: There can be some and I think that's one of the reasons that I talk about increasing the realism and really giving people an opportunity to practice those situations that are not so textbook because the more you give people the opportunity to sort of have to think on the fly, as you will, about what they're dealing with, what they're faced with, what their options

are, the more that we sort of reinforce that skill for them, I think the better prepared they're going to be for dealing with those situations.

DR. WILSON: And how does a pilot's experience impact their ability to handle a non-textbook emergency, if we look at a novice pilot versus a pilot with 20,000 hours of experience?

DR. BURIAN: Well, there's a line of research related to Recognition Prime Decision Making, is what it's called, and what that involves is that people are able to very quickly sort of see a situation and are able to say hey, you know what, this looks very similar to something else that I have experienced and because of that recognizing those cues and are able to sort of see that, the idea is that you are now able to then come up with a solution much more quickly. And obviously, in order to be able to recognize these kinds of cues, you have to have been exposed to a number of them. So typically, people who are far more experienced and have been exposed to a variety of these different kinds of situations tend to be able to make those kinds of recognitions and decisions more quickly, so expert versus novice is where that really shows up.

DR. WILSON: Great. Now, let's move on to the checklist design aspect that you discussed in your presentation, and you mentioned that we can't always design a checklist for every possible scenario, but I can envision three potential scenarios that a pilot could be faced with, a scenario where they have a

checklist and it works exactly as designed; a checklist that may work some aspects of it but is not completely perfect; and then a scenario where no checklist applies for the event that they're being faced with. What research have you done that has examined these different potential scenarios and what have you found?

DR. BURIAN: Well, we never got that far in our project before the Aviation Safety Program ended in 2005 and that's, I think, one of the great frustrations that I have is that I'm able to give guidance related to what we know about human performance, what we were able to find out from the analyses that we performed, but we haven't been able to do a lot of empirical studies where we actually put people in the simulators with these different kinds of scenarios and tested out and been able to then say, hey, you know, here's different approaches to the training based on that or here's different approaches to the checklist design based on that and that's one of the things that's really lacking in the community. I kind of had some -- my heart went out to my FAA colleague there when he was talking about the guidance. There's not a whole lot out there right now to really help support people in the design of emergency and abnormal checklists. There is some, but not a lot.

DR. WILSON: Okay, thank you. What guidance can you proved regarding how a checklist can be written to deal with the range of possible scenarios? You mentioned that some may be at high altitude, some at low altitude, the context may always be

different, so what sort of guidance can you provide to operators on how to design a checklist for that situation?

DR. BURIAN: Well, what I've done is, in a much more detailed way than I presented to you here, identified a variety of different layers of contextual factors that folks should consider and when I'm working with individuals at air carriers, primarily in helping them think through a checklist that they are working on, as something that they're trying to design, I actively question that and we go through the different layers and we really try to look at how well this checklist will work in this condition versus that condition and so work with them that way.

DR. WILSON: Great, thank you. And if you could expand a little bit more on the gates or opt-out points, if you have an example of maybe an operator that you worked with where you built in these opt-out points on the checklist?

DR. BURIAN: I actually haven't worked with anyone on that, specifically, but the idea came -- well, actually no, I take that back. There was one air carrier that I did some work with on some smoke, first and fumes checklist and that's actually where the idea initially came from. And the idea is that you build in a point where you need to sort of, again, remind people to step back from their situation and in this particular checklist, the idea was to remind the crew that at this moment you're dealing with an in-flight smoke/fire situation. At some point, the smoke on the cockpit may actually become the greater concern than figuring out

where the source is and you need to be shifting and focusing on smoke evacuation kinds of activities in addition to working toward a diversion and landing and those kinds of things. And so it was through my conversations in working with them that the notion of putting in these gates and opt-out points -- and I have to say that gates and opt-out points is my language for it, but most of the people would just refer to it, as they did, as a conditional statement where you basically say if this is an issue, go here and do this instead; if this is an issue, go somewhere else, but the underlying intent is really to get people to think a little bit about what they're situation is, which is very difficult to do when you're under such high stress.

DR. WILSON: Continuing with the in-flight fire example that you gave and considering the accident that we're dealing with, the flight crew never made it to the third page of the checklist, which was the ditching portion of it, how to fly the approach and conduct the landing. What are the benefits and risks of moving items such as those to the beginning of a checklist versus keeping them at the end?

DR. BURIAN: This is one of the tough things, is how to navigate through a checklist, so -- and this is something that the industry has really struggled with and it's particularly difficult with paper-based checklists. Electronic checklist systems can help a great deal in terms of navigating to those specific steps that are most appropriate depending upon how the system is

designed. But paper checklists, we really rely upon a bunch of conditional statements. So what you're suggesting is to actually take these items and move it up to the very beginning. Well, now you have a situation where you might have people who need to ditch, but they're at altitude and so now these steps don't apply to them, so they have to skip over those steps to get to the steps that do apply to their situation. And they would then continue on down and if they do get to a point where they do need to worry about ditching, now the steps that they needed are located at the very beginning of the checklist, so you're either now repeating those same items at the end.

Or another option would be simply to have a conditional statement at the very beginning of the checklist rather than move those steps up, to have a conditional statement that says if you're at this altitude, you know, go here; if you're needing to ditch, if you're below this altitude, go to Step 27, you know, or whatever, and so move them to that particular step right away. Again, though, that creates a lot of difficulties for crews because they're having to do a lot of jumping around even within the checklist. People can get lost.

DR. WILSON: And what are the benefits and challenges of using memory items with checklists?

DR. BURIAN: Well, as I mentioned earlier, memory is one of those cognitive processes that is most highly affected during emergencies and as we found, through a lot of our observations

from the training scenarios conducted in simulators, that even crews who were prepared, who had studied and memorized -- gone through their memory items right before going into recurrent training, oftentimes they even still made errors in completing the memory steps. We found that they sometimes completed steps that were not memory items, sometimes they completed the items in an order that was considered incorrect. Oftentimes they missed things that they were supposed to have done. So even in a training environment, it can be stressful enough that memory can fail the crew, so I think memory items should be minimized as much as possible and actually, the industry has really been moving in that direction for a while now.

DR. WILSON: Okay, thank you. And regarding, again, as I mentioned, that the ditching portion of the checklist was on Page 3 of the dual engine failure checklist, so one of the things that we're considering is the length of the engine dual failure checklist. What are your thoughts on the length of emergency or abnormal procedure checklists?

DR. BURIAN: Yeah. This is another one of those things that I really wanted to be able to study empirically because on one hand, because we know that human cognition is not going to be operating at 100 percent peak efficiency during these events, it can be quite helpful to provide a lot of extra information in the checklists, a lot of extra notes, a lot of information about the aircraft limitations or capabilities based upon what's going on

with the aircraft, so it can be quite helpful to have all of this extra information in there. But of course, the more information you provide, the longer the checklist, and so the longer it takes to get through that and when you have a highly time-critical situation such as this, it then creates the exact scenario that this crew faced, which is they didn't get through all the different items. So we really need to take a more careful look at some of these kinds of things.

Clearly, if there were a way for crews to be able to evaluate how time critical their situation was, how much time they had for things, we could then use that information to guide them to a very few shortened items that they need to complete before they do something else. It can be difficult for some crews to actually be able to make that determination. In this situation, the crew was pretty clear that they were going down and they didn't have very long. So in this situation, that kind of guidance might have been quite helpful.

DR. WILSON: What policies or guidance is there from the industry or the FAA on how to train for or develop checklists for abnormal or emergency situations?

DR. BURIAN: There's a little bit of information available from the FAA on emergency and abnormal checklists. Some of it appears in the POI handbook, the Principal Operations Inspector's handbook, and there are some documents that were produced by the FAA in the early and mid '90s that pertained,

overall, to sort of a checklist design, but those were mostly focused on normal checklists and they were in response to some accidents that -- where some normal checklist steps had gotten missed and so they mentioned a few different things related to emergency and abnormal checklists, but they really weren't geared specifically to that. There are a number of people, myself included and others, that have done some research and so we have some reports and some conference papers and whatnot that we've written that talk a little bit about that.

Gabrielle DeBrito (ph.), in particular, who's done some work with Airbus, had done some work a few years ago on some design of emergency and abnormal checklists specifically related to the ECAM. And I think right now, the most comprehensive material that's available for the industry in terms of guidance in the design of these things is probably available through the Civil Aviation Authority in the United Kingdom.

They put together a number of different reports, so they have a CAP document for this. It's called CAP 676 and it's on the design of emergency and abnormal checklists and it's not bad at all, for what it is. The issue that I have with it is that it doesn't go far enough. There's a lot of questions that people have that are not answered there and again, this goes back to the point I made a moment ago that we just don't have a lot of good empirical data to be able to help guide the design and development of the checklists.

DR. WILSON: Great. And one final question for you. We definitely heard a lot today from Captain Sullenberger saying that there just wasn't a lot of time to react. We heard from Captain Hope and also Captain Parisis that training in a simulator for events like this is very difficult. I just want to get some of your takeaway thoughts from everything that you've heard today. What sort of advice or guidance do you have that you can provide to those of us that are here today and those of us watching that if a situation like this is to happen again, where should we go from here, what can we do, what are the first steps towards making this situation more manageable for a future crew?

DR. BURIAN: I think the takeaway points that I would want to emphasize are some that I've already made in the presentation. One would be to increase the realism of training and really give the crews an opportunity to practice those situations that don't have a clear cut answer, that don't have good checklists, have an opportunity to really decide how to manage the workload and really sort of think things through strategically, so I would think that that would be on important take-home point.

Another take-home point that I would really like folks to go away with is that the design of emergency and abnormal checklists is not easy, it is really tough, and I've had an opportunity to work with some really fabulous people that are highly intelligent and very dedicated and have worked very

sincerely on putting together the very best products they possibly can. But we, as an industry, really need to think about how we can better design these checklists and I think again, research, although it's probably a little self-serving for me to say it, as a researcher, I think that this is essential, to be able to give some guidance that's based on some hard, empirical data to help people in making the very tough decisions in how to best design these checklists.

DR. WILSON: Great. Thank you, Dr. Burian, for your time and to all of the other panel members. Mr. Chairman, we have no more questions. I'm sorry.

CHAIRMAN SUMWALT: I believe there's actually one more from the Technical Panel.

MR. O'CALLAGHAN: Yes, thank you. I have a question to follow up a little bit on what Captains Hope and Parisis had to say about the use of the simulator during a ditching scenario. Earlier in the day, Captain Sullenberger testified that he thought it might be useful to train a ditching scenario to touchdown to learn such things or to experience such things as the control of the flight path and the actual water entry.

Captain Parisis, you mentioned that the simulator may not be the appropriate tool to go further into the ditching procedure beyond a certain altitude, and Captain Hope, I think you mentioned that perhaps one reason for that may be that the simulator behaves badly in terms of a hard reset and losing a lot

of time. And my question is, is it the -- because the reset problem, is that the main reason or are there simulator fidelity issues associated with it? Would negative training be an issue there or can -- at least from the physics point of view and the operations point of view, if you could get away from the reset problem, would the simulator be an appropriate tool for actually learning how to put the airplane in the water?

CAPT. PARISIS: So for me, the main issue is the negative training. If we trend beyond the capacity, the fidelity, of the simulator, this could lead to a negative training, so today we are not capable of having high fidelity vision that will be a positive training for the ditching situation.

CAPT. HOPE: I would have to agree on the negative learning aspect of really not having a lot of data in the industry to actually give to my instructors or evaluators on how to actually teach that water entry.

MR. O'CALLAGHAN: Thank you. And just a brief follow-up, can you describe or contemplate some of the consequences of negative training that you're envisioning?

CAPT. PARISIS: So the vision -- would not provide the crew with the adequate cue that you will have in the real situation and you may rely on specific cue that's only specific to the simulator that you will not have in the real situation, so that's why we have to be very careful of the possibility of negative training in this kind of situation when you go beyond the

capacity of the simulator.

MR. O'CALLAGHAN: Thank you. That's all I have.

CHAIRMAN SUMWALT: Thank you. Any other questions from the Technical Panel?

(No response.)

PARTY QUESTIONS

CHAIRMAN SUMWALT: Thank you. We'll now go to the parties and Airbus, US Airways, and FAA, you each have witnesses to testify, so Captain Canto, would you like to go in turn, you would be next, or would you prefer to go towards the end of the pack?

CAPT. CANTO: We will go last, please.

CHAIRMAN SUMWALT: Okay. And US Airways, same question.

MR. MORELL: We'll be second-to-last, please.

CHAIRMAN SUMWALT: Right. And FAA?

MR. HARRIS: I think that leaves the third-to-last spot, sir.

CHAIRMAN SUMWALT: Excellent. Very well, very well. We will start now with CFM International.

MR. MILLS: We have no questions, thank you.

CHAIRMAN SUMWALT: Thank you. USAPA.

CAPT. SICCHIO: Yes. Thank you, Mr. Chairman. Good afternoon to our panel. Thank you very much. My apologies. Actually, I'd like to start with -- okay, my apologies. I'd like to start, if you don't mind, with Captain Parisis. During your

review of possible changes following Flight 1549, would you be able to comment on the appropriateness of the flight crew actions immediately following the encounter, in other words, the start of the APU and switching the ignition to continuous?

CAPT. PARISIS: Yes, for sure we take this into consideration, so -- is the microphone working?

UNIDENTIFIED SPEAKER: Yes.

CAPT. PARISIS: So we take this into consideration. We think that this was very good initiative from the captain of this flight, however it was -- so we are looking to this to be inserted maybe in certain situation and we would highlight what would be the situation where it should be done if during the review we find that it is appropriate in this -- but maybe not in all of them, so we try to provide some guidance for the crew following this event.

CAPT. SICCHIO: Okay, thank you. And actually while I have you, Captain Parisis, and I might also refer this to the other panelists here, but Captain Parisis, did I understand correctly in your testimony earlier that you would consider Flight 1549 to not really be a ditching, but in fact a forced landing on water. Is that a correct assumption?

CAPT. PARISIS: Yes, that's correct. That's on the first slide of my presentation. We consider it as --

CHAIRMAN SUMWALT: Excuse me, we're having difficulty hearing you and I think Captain Sicchio, I think if you would really grab that microphone closely, then they could turn the

volume down and I don't know if someone's keeping an open mike there which is contributing to the feedback, but we'll try and get --

CAPT. PARISIS: So as I said in my presentation on the first slide, we definitely consider this event as being an emergency landing on the water. That answers your question?

CAPT. SICCHIO: Yes, thank you. And Captain Hope, would you care to comment on that, as well?

CAPT. HOPE: Yes. I would have to agree that we're looking at a forced landing on water.

CAPT. SICCHIO: Thank you. Anybody else on the panel, Dr. Burian, good afternoon, would you care to comment on that at this point?

DR. BURIAN: No, I'll defer to my colleagues on that one, thank you.

CAPT. SICCHIO: And Mr. Duncan?

MR. DUNCAN: I'll defer, also.

CAPT. SICCHIO: Thank you. Dr. Burian, I wonder, in your presentation you mentioned the textbook versus non-textbook situations. Would you consider Flight 1549 to be a textbook or a non-textbook emergency situation?

DR. BURIAN: I believe we would consider this non-textbook.

CAPT. SICCHIO: And based on what we've heard today and your knowledge of the event, would you consider that to be an

event that was handled well?

DR. BURIAN: We would consider it, actually, an event that was not handled well. Although the flight crew handled it well, there was a problem with the procedures that they were supposed to be using. They weren't able to get to the particular items that they needed to and so by not handling well, it doesn't just refer to how the individuals were behaving, but also the materials that they were supposed to use, the resources to help support them, the tools.

CAPT. SICCHIO: Okay, thank you. Now, along those lines, you've mentioned, in training, as a possible way to enhance performance of flight crews, and you mentioned perhaps using training technique where the procedures that are in place would not work properly, in other words, I believe the example you used, an engine would not relight or a switch would not operate properly. Could you, perhaps, describe that in relationship to the negative training term that has come up, that certainly we've all been privy to in our careers?

DR. BURIAN: Sure. Oftentimes what drives the training when people are asked to kind of go through the entire procedure and it actually is successful, the intent, typically, by the instructor is to make sure that the crews are exposed to all the different steps that are included in the procedure, so they're trying to gain some familiarity with the actual procedures that they're supposed to complete, some familiarity with the actual

checklist, itself, how it looks, where things are located, that sort of thing. The intention of giving people opportunities where they don't have things work as they are supposed to is really to broaden their experience, so I talked a little bit about recognition prime decision making. You broaden their experience by giving them opportunities to experience where things don't work out because oftentimes they don't in real life, the checklist doesn't quite match what you're working on. The procedures, you know, can only go so far. You can't train for everything, you can't develop a procedure for everything.

So by training people in situations that are not exactly like what they would hope for, you give them this broader experience. Negative training really refers to the idea of setting people up for one kind of situation where something else actually occurs in reality. If we train them for a procedure that works beautifully and in fact, it really does, then there's no problem. But in some ways, you might actually think that by only training people for procedures that work beautifully, we're actually setting them up for those situations where they don't work exactly as intended.

CAPT. SICCHIO: Okay, thank you. A good explanation, certainly. Is there any danger there, however, in a crew losing faith in the procedures? For instance, in this case, should a crew in training go through the engine dual failure checklist and not have the engines respond, would that not, perhaps, take them

out of the checklist in the real world before they, perhaps, should give up on it? Is there any danger there that you see?

DR. BURIAN: Well, I think that's certainly something that's going to have be addressed during training. In this particular situation, with an engine failure, oftentimes in those sorts of checklists there are steps that are -- you know, if it didn't work the first time, do it again, you know, try it again or try it in a different way, so if it didn't work with windmill, try starter assist start or some other, you know, mechanism for getting the engine started. So that can actually be included in the procedure to give the crews some support. But you also don't want to create a checklist that sort of keeps people sucked in to trying the same thing over and over and over again if it's not going to help.

CAPT. SICCHIO: Yes, I certainly can see, and I also see when you refer to the difficulty of designing these checklists, certainly this case was evident, Flight 1549, where the crew certainly did exactly what they were doing or what they were supposed to do on the checklist. At one point, however, they, based on the time constraint, had to give up and they did, and I supposed I would like to ask your opinion on that, in looking to the future, in a future design, is there a way that you see a solution to this problem in this particular flight?

DR. BURIAN: Well, what I talked about a little bit ago in terms of the opt-out points or using conditionals to help

people decide in terms of how much time they had, how much -- you know, the time criticality makes that sort of evaluation really support crews in doing that. This crew didn't need that kind of guidance. They were pretty clear on what was going on and how about much time and so they did, as far as I can tell, everything they possibly could with the checklist until it became a point where they needed to abandon it and focus on something else. So they did not fall into that sort of trap. But to support crews, we can certainly include that kind of information, those kind of little notes, decision points, opt-out points, to help support that.

CAPT. SICCHIO: Okay, thank you. I appreciate your candor there. I know this is difficult and no pressure on you developing that answer. Okay. Thank you. I guess, if you don't mind, I'll jump to another subject. Mr. Duncan, could you perhaps describe for us the FAA's, let's say, procedures or what policies and/or safeguard you might have in terms of communicating certification criteria over to the flight operations community and this might not be quite clear to you where I'm going here, but essentially there's -- it seems to me, in the previous testimony, that there is a certain certification criteria for aircraft ditching and based on that, there may be flight operations procedures that are required to ensure that a crew might be able to meet that understanding that this particular flight may not have been a ditching. Could you perhaps comment on the way FAA

operates in that area to ensure that flight crews actually have the proper procedures in place to ensure that we comply with certification?

MR. DUNCAN: Let me say first that I'm not the person -- I don't have expertise in that particular area. There will likely be folks here that will have that expertise. I will say that we use our aircraft evaluation groups to evaluate aircraft, look at operational suitability and deal with passing on that information along with the flight standardization boards.

CAPT. SICCHIO: Okay, thank you. I appreciate that. Just a couple of more questions.

CHAIRMAN SUMWALT: Well, Mr. Sicchio, I think -- would you be willing to -- we've been about 10 minutes on this. You want to wait for a next round?

CAPT. SICCHIO: Absolutely. Thank you very much.

CHAIRMAN SUMWALT: Thank you, Captain. We'll go to AFA.

MR. KOLANDER: AFA has no questions at this time.

CHAIRMAN SUMWALT: Thank you. So this puts us to Airbus.

CAPT. CANTO: No questions, Mr. Chairman.

CHAIRMAN SUMWALT: US Airways.

MR. MORELL: Captain Hope -- could you bring up the presentation on the Threat and Error Management, please? Can you hear me? This is directed to Captain Hope and I was wondering if we could bring up Captain Hope's presentation and the Threat and

Error Management slide. Captain Hope, Dr. Burian brought up some key points when it comes to crews dealing with non-normal situations and one of those points was task loading and saturation and shedding of tasks. And is the policy or the model that US Airways uses with Threat and Error Management, does that deal with that?

CAPT. HOPE: Absolutely. There's additional verbiage that goes along with our Threat and Error Management that talks specifically about tasks over time and how task loading, in itself, can drive you out of the green and closer to the red, and by limiting your tasks or increasing your time can drive you from the red back into the green. One of the things that we've noticed in flight training and evaluating is a pilot may or may not look at the amount of fuel that is on the aircraft.

Now, obviously this is not the situation here today, but looking at the amount of fuel that's on an aircraft and looking at how much time do I have to do these non-normal checklists and how I can reduce my task loading by going into a holding pattern and utilizing some of that fuel that's onboard the airplane to take me out of the red or yellow back into the green.

MR. MORELL: And Captain Hope, also with respect to that, do the barriers provide any assistance to the pilots in order to decrease their task loading?

CAPT. HOPE: Absolutely. Each pilot, as I said, has a set of these barriers and by erecting these barriers and following

these barriers, policies, procedures, flows, checklists, automation, external resources, all of these can reduce our task loading.

MR. MORELL: And the third point is that one of the other issues that Dr. Burian brought up, or recommendations, was that training that is done with the pilots is to be put in a scenario where their task loading is increased and that they have to deal with these types of situations. Is the Advance Qualification Program type training, is that conducive to that type of training?

CAPT. HOPE: Absolutely. At US Airways, our evaluation and up to our evaluations and our qualification footprint continues to drive closer and closer to scenario based and our recurrent training or continuing qualification program evaluation is driven to scenario based after maneuvers are practiced the day before, and as we tell our pilots, it's no different in our recurrent training or continuing qualification programs, it's no different than before they come into the training house.

And that is that they can be out on any routine flight and something can happen, something, a trigger can take place. It may be something as simple as a sick passenger in the back and following the proper procedures, policies, to the airline, something that may drive them into the yellow or something as catastrophic as engine failures or hydraulic failures that may put them into the red. But we use those triggers, as we refer to

them, in scenario based type evaluations because this is what our pilots are faced with every day.

MR. MORELL: When you say scenario based, could you explain what that really means?

CAPT. HOPE: Absolutely. We use line operational evaluations. We physically, in the evaluation gates, have run a routine flight out of any one of our hubs to a destination. We may get to that destination or we may have to divert depending on the trigger severity. So all of our evaluations are based on what our pilots do every day.

MR. MORELL: And during those scenarios is the task loading increased as time goes on?

CAPT. HOPE: Yes. Like I said and what we saw here early on in this accident, our pilots were in the green. Pilots go in and out of the green based on what's currently happening to them. For example, they could be at the gate prior to pushback and something doesn't work properly or they'll have to get into the MEL, the Minimum Equipment List.

They'll have to contact their dispatchers. Those are a prime example of the barriers that we've just erected to follow the policies/procedures flows. How about the external resources of contacting their dispatcher, how about getting maintenance involved? We haven't even gotten off the gate yet and we've already had some simple task loading that's taking place which can happen in a real life environment.

MR. MORELL: Thank you, Captain Hope.

CHAIRMAN SUMWALT: Okay. And FAA?

MR. HARRIS: Thank you, Mr. Chairman. Dr. Burian, Captain Sullenberger referred to his training as contributing to the outcome of this accident, yet as I understand it, and the testimony of Captain Hope, he had no specific training in the Airbus A320 on forced landings on water after a low-altitude dual engine loss of thrust on climb-out. Given your background and study in human factors, in human performance, rather, in emergency situations, can you comment on how pilots process training to apply it to a new scenario, what I think you referred to as on-the-fly type decision making?

DR. BURIAN: The issue that we're interested in is the degree to which training might generalize from one type of sort of situation across to other situations that have not been specifically trained and Dr. Wilson kind of asked a question related to this. What we hope to do with our training, particularly when we're presenting a lot of different situations to crews, especially ones that don't have a particular clear cut response, is to give them the opportunity to think about how they might make decisions, how they might be strategic, how they might evaluate what's going on. So it's those kinds of skills at that sort of level, that evaluative level, the practice in making decisions that would generalize across the various sorts of situations. And of course, because Captain Sullenberger has so

much experience, he's had a lot of opportunity to be in situations where he's had to make these kinds of decisions, so it's that kind of thing that we are hoping to be able to reinforce through our training that would generalize the best.

MR. HARRIS: And would you say that scenario-based training such as in the Advance Qualification Program would support exercising those decision making skills even thought they may not be specifically to the event in question?

DR. BURIAN: I think it certainly can but again, we don't want our scenarios to be so cut and dry and so textbook where everything always sort of unfolds exactly as you might expect.

MR. HARRIS: And a final question for you, Doctor. What actions have you seen among manufacturers or air carriers in the use of information from your study?

DR. BURIAN: In terms of the air carriers, I've actually seen a number of changes in some of the checklists and with one air carrier I consulted, they were actually stepping back and redesigning their entire QRH and so I was able to share with them a number of the studies that I had done, looking at a comparison of QRH and talked about a variety of different design issues and they incorporated a lot of that thinking into the design of their QRH, consulted with several manufacturers, and I believe that that information has influenced some of the design decisions that they've made in some of their checklists. There's -- I'll just

stop there, I guess.

MR. HARRIS: Well, thank you very much. I think you answered the question quite well. Captain Hope, you made mention to the AC Bus failure information related to the A320 and how the NTSB recommendations have it incorporated into some of the work and guidance that you provide for your crews. How did US Airways become aware of the NTSB recommendations?

CAPT. HOPE: We look at all industries as far as the different governing bodies, if you will, safety boards. We look at all sorts of recommendations that are out there and how that impacts our airline. And having two of these incidents out of the 49, we were very concerned about them and so we wanted to follow them and see where they went.

MR. HARRIS: Very good. Were you aware that the FAA issued a safety alert for operators on this issue, also? Was that part of your information that you used?

CAPT. HOPE: Yes, sir.

MR. HARRIS: Thank you very much. Mr. Duncan, this is actually leveraging off of the discussion with Dr. Burian, but you're a flight instructor, correct?

MR. DUNCAN: Yes, sir.

MR. HARRIS: And one of the areas of knowledge that you have to have to hold that certificate has to do with understanding some laws of learning and part of that has to do with levels of learning -- understanding, application and correlation being the

highest. Can you comment on the level of performance that a pilot would be applying in the circumstance of facing a situation for which he had had no specific training?

MR. DUNCAN: Well, clearly in this case, we're talking about correlation. We're talking about using skill sets, independent skill sets, two or more, and putting them together in order to come out with this successful event. And I would say scenario-based training is the place where we develop those kinds of things and clearly, that's been talked about a lot here. The traditional 121 E and F training provides the opportunity to the operator to use scenarios to the extent that they want to and clearly, AQP requires that and provides a greater opportunity to do that, as well as collecting data and the need to collect data and the opportunity to use that data to point the training program in a direction that emulates the day-to-day kinds of operations and those kinds of things that are a high probability that you're going to get into to develop those skill sets. And N and O (ph.), which will be out -- which is proposed at this time will also provide some additional opportunities.

MR. HARRIS: And you're speaking of Part 121 --

MR. DUNCAN: Correct.

MR. HARRIS: Very well. Thank you, sir. I've completed our questions.

CHAIRMAN SUMWALT: Thank you. We'll go with the second round and we'll just do the second round in the order for table,

so USAPA.

CAPT. SICCHIO: Thank you, Mr. Chairman. I guess -- oh, Captain Hope, just so that there's -- I want to make sure that I'm clear on this and for the record, you mentioned in earlier testimony that we have pilots that go back and forth between Airbus, Boeing, and -- aircraft. Could you describe what is entailed in that process? We do not have dual qualification at US Airways, do we?

CAPT. HOPE: No, we do not. If a pilot were to leave one type of manufactured type aircraft, he would go to a full initial on the next aircraft.

CAPT. SICCHIO: Thank you very much. Also, you mentioned quite a bit, actually, about AQP and I wonder if you could tell us about some of the other data sources that AQP uses, you know, an example would be, of course, FOQA and things of that nature.

CAPT. HOPE: Certainly. We've actually put together what we call an FDAG group, a Flight Data Analysis Group, because we look at all sorts of streams of data, data coming in from all of our training events that's in the minds of our check airmen, instructor pilots, as one source of pilot proficiency for our population of pilots at US Airways. We look at FOQA, as you say, the FOQA recorders, from how the aircraft are actually being flown by our pilots and we look at a solo, a special operational audit, as another source of data to the FDAG group. We look at operating

experience after an initial simulator or qualification when the pilot first goes to that aircraft and performs operating experience with a check airman. So we collect all of those data points and then look also to the industry to see what data the industry can bring to our FDAG group. That's one of the reasons why US Airways in the flight operations, is getting ready and has already started to launch a safety management system because a lot of these parts are already been working for a number of years for US Airways.

CAPT. SICCHIO: Thank you, Captain Hope. Captain Hope, for you, one final question. Based on the testimony today and your familiarity with the events of Flight 1549 and also your experience in CRM and TEM, Threat and Error Management, would you care to comment on the effectiveness of Threat and Error Management and CRM on this particular flight?

CAPT. HOPE: I would. Although the textbook non-normal checklist may not have been followed exactly due to the time, I look at the Threat and Error Management that was employed by our crew as textbook and I really believe that, in my opinion, led to a lot of the successes of what happened to 1549.

CAPT. SICCHIO: Thank you very much. No further questions.

CHAIRMAN SUMWALT: Thank you. Any other follow-up questions from the parties? Airbus.

CAPT. CANTO: Yes, thank you. This is addressed to

Captain Parisis. With regards to the reference by Captain Hope regarding the numerous events in the industry regarding the loss of AC bus power and loss of the PFD nav displays and other instruments within the flight deck, what kind of guidance was Airbus and specifically, Airbus training, providing to the industry at large?

CAPT. PARISIS: I didn't prepare for this specific subject. I do not have, in my mind, the exact, but I remember -- that we provide for sure information. I don't have the exact data with me.

CAPT. CANTO: But we did provide recommendations and guidance to our customers on a timely basis on how they should go about correcting and identifying these issues, is that correct?

CAPT. PARISIS: Correct.

CAPT. CANTO: Thank you.

CHAIRMAN SUMWALT: Any other follow-up questions from the parties? Okay, it's my understanding we have a follow-up question on the Technical Panel.

TECHNICAL PANEL QUESTIONS

DR. WILSON: Yes, thank you. Regarding what Captain Hope and also Captain Parisis mentioned that this accident was a forced landing on water versus a ditching, I'd appreciate it if you could explain your reasoning for that.

CAPT. PARISIS: The ditching, as it is prepared in the -- is a planned event with time to go through all the procedures.

We give you some information on how to comply with, time to prepare for the aircraft, including the cabin -- the pilots in term of mindset, what to do, how to do it. In this unique event that we consider being an emergency landing on water, there were no time, very limited time, to prepare the aircraft, should it be the cabin, for sure, but also the mindset of the pilot, with no time to refer to procedures, so it was definitely beyond -- procedures.

DR. WILSON: Captain Hope, do you have anything to add?

CAPT. HOPE: Just that when we look at the ditching provided by the manufacturer, in this case, Airbus, ditching is predicated on engines running; you're ditching for another reason. That's why I agree with my colleague here that it was a forced landing on water.

DR. WILSON: Okay. So just to clarify so that it's clear in my head, if the flight crew had had time to get through the ditching portion of the dual engine failure checklist, this would be considered a ditching, is that a fair statement?

CAPT. PARISIS: So for me, in this situation, would be in the ditching part of the engine dual failure procedure, so the word ditching will be applicable in the flight -- context of this procedure that may not be applicable to other context.

DR. WILSON: Okay, thank you. I have no further questions.

CHAIRMAN SUMWALT: Thank you. We'll turn to the Board

of Inquiry. Dr. Kolly.

BOARD OF INQUIRY QUESTIONS

DR. KOLLY: Captain Hope, you mentioned about your scenario based training program. Do any of these scenarios involve bird strikes?

CAPT. HOPE: It is an option for our instructors or evaluators. Going back to what was said earlier, they are not very canned at all. We give our check airmen the option of different triggers to use in this particular scenario and when we look at an engine failure on takeoff, one of the options to create damage on that engine on takeoff is to use birds ingesting into that engine.

DR. KOLLY: Can you explain a little bit about how that would go about in a training scenario?

CAPT. HOPE: In a training scenario, simply, the instructor would fail an engine and there's an option on the instructor's screen to use either a fire or birds or different types of reasons why that engine's going to fail at that critical time.

DR. KOLLY: Is there any training with regard to bird avoidance?

CAPT. HOPE: The only avoidance that we have are what is in our standard operating procedures and that is that we brief, using our Threat and Error Management, the potential for errors. When we hear birds on the ATIS or that ATC would tell us, and then

we would use the effective communication to say, you know, we need to be concerned about the birds that we've been told, so that's the communication between the pilots.

DR. KOLLY: Do you train any specific techniques, avoidance techniques, or mitigation techniques at all?

CAPT. HOPE: We haven't found any that's in the industry that we can draw on.

DR. KOLLY: Thank you.

CHAIRMAN SUMWALT: Mr. DeLisi.

MR. DELISI: Thank you. Captain Parisis, can you help me understand this correctly? Is the ECAM capable of bringing up a ditching procedure for a crew to follow?

CAPT. PARISIS: No, definitely not. This cannot be auto-detected by the system.

MR. DELISI: So the ditching procedure only exists in writing, in the QRH or other handbook?

CAPT. PARISIS: Correct.

MR. DELISI: Okay. Captain Hope, the A320 fleet at US Air, I understand that some of the airplanes are equipped for extended over-water operation and some are not. Can you give us a breakdown?

CAPT. HOPE: I don't have exact numbers for you. Our fleet almost doubled in size after our merge with America West. At one time, we had a certain number of 319s and 320s that were EOW equipped, but as Captain Sullenberger pointed out, it's very

obvious to a pilot when he picks up the flight deck maintenance log on the airplane and it spells out in red letters EOW.

MR. DELISI: And is there a certain flight route requirement that would make it necessary to use one of the extended over-water aircraft?

CAPT. HOPE: Absolutely. With our hubs in Boston, LaGuardia, Philadelphia, and Charlotte, we do an awful lot of western Atlantic type Class 2 navigation flying, if you will, to the Caribbean, to Bermuda and the Caribbean.

MR. DELISI: And are all US Airways pilots interchangeable in terms of flying those routes on the right aircraft?

CAPT. HOPE: Yes.

MR. DELISI: Okay. Do I have this correct, also, that -- we talked a lot about a procedure for ditching and a procedure for a dual engine failure, but am I correct in gathering that there is not a procedure for a forced landing?

CAPT. PARISIS: So we do have a procedure for ditching situation, so that's the -- consideration that you have -- available, you have time to prepare for ditching, so the name of the procedure is ditching, is a paper procedure. Then you have the situation of the engine dual failure, either fuel remaining or no fuel remaining, and this -- both situation can lead to a decision because of the engine and not capable of restarting to do a forced landing on the ground or what we use the

word ditching in this specific context, a forced landing that will be on the water. So it will be part on the -- getting the -- would be part of the engine dual failure procedures. What we consider is that this unique event is beyond these two situation and it's an emergency landing on water with no time to prepare.

MR. DELISI: So at the end of the dual engine checklist is where any guidance would be regarding making an off-airport landing, is that correct?

CAPT. PARISIS: Correct.

MR. DELISI: Okay. One final question. There's been some talk by both Captain Hope and Captain Parisis about training for ditching being a scenario with power. Can you help me understand that? If you've got engines that are still generating power, why would you land in the water?

CAPT. PARISIS: So one of the example I gave in the presentation is persisting cabin fire that will make the captain to decide that the best solution would be to prepare for a ditching situation. Another solution could be when the captain find out that there will be not enough fuel to go to a destination. In this situation, it's good airmanship to decide not to wait for the engine to run out of fuel, but to prepare yourself for ditching with engine thrust available, giving you the opportunity in case of that to go wrong, to have another trial, so that's some situation when you may want to ditch the airplane with

engine thrust available.

MR. DELISI: We're going to have more conversation at the hearing about the threat that birds might pose to aviation and based on what we've already learned from 1549, is there any thought that training pilots for a scenario where they might be ditching or performing a forced landing without engine thrust would be advantageous?

CAPT. HOPE: I think that that would probably be one of the results of the outcome of this accident.

MR. DELISI: Great. Thank you.

CHAIRMAN SUMWALT: Yes, thank you. A very interesting panel. Dr. Burian, you had mentioned -- and I just want to clarify this for my own self, as well as people who may be here. You mentioned that -- well, first of all, have you studied the cockpit voice recorder transcript?

DR. BURIAN: Not for this accident, no.

CHAIRMAN SUMWALT: No, not for this one. So just to clarify, when you say that this was not handled well, you were referring to what, exactly?

DR. BURIAN: I was referring to the procedures that the crew had to use. There's been discussion about their length and the fact that they weren't able to get to the section that would actually have helped them prepare for ditching.

CHAIRMAN SUMWALT: Thank you. You're familiar, Dr. Burian, with the Rasmussen's SRK Taxonomy, perhaps? It's a

question or no?

DR. BURIAN: No.

CHAIRMAN SUMWALT: Okay, thank you. That was a short question. What I'd like to do is before everybody gets up, we will take a break in about 30 seconds, but I know that some of you would like to eat and drink coffee and things like that and we would prefer that you not do that in the board room. However, there is a conference room outside -- inside of security, but outside of these doors for the board room that does have a live video feed, so if you would like to have coffee or something and still keep up with the proceedings, that is a good place to do it. We will take a break. We'll take a break for -- well, according to that clock, let's be back at -- in 18 minutes, so that's what, 2:40? We are in recess. Thank you.

(Off the record.)

(On the record.)

HEARING OFFICER BENZON: Can we take our seats, please?

CHAIRMAN SUMWALT: Okay. All right, Mr. Benzon, you ready to swear the next panel?

HEARING OFFICER BENZON: I am. They're on the stand, sir. If they wouldn't mind standing up, please? Raise your right hands.

(Witnesses sworn.)

HEARING OFFICER BENZON: Please have your seats. And gentlemen, starting with Dr. Dolbeer, could you state your names

and occupations for the record?

DR. DOLBEER: Yes, I'm Richard Dolbeer and I'm a Science Advisor for the U.S. Department of Agriculture Wildlife Services Program where I've been employed as a scientist for the past 36 years. I've published about 170 scientific papers dealing with understanding and resolving conflicts between wildlife and people. About half of those have involved aviation related issues. I've also had extensive experience working in New York City with the Port Authority of New York and New Jersey, dealing with bird strikes at New York City airports and have published about 10 papers related to that work. And I served as chairperson a Bird Strike Committee USA, which is a government/private aviation industry organization for the 11-year period, 1997 to 2008. Are you ready for me to begin my testimony?

HEARING OFFICER BENZON: We need to identify the other folks on the panel first, sir.

DR. DOLBEER: Oh, I'm sorry.

HEARING OFFICER BENZON: Go ahead.

MR. BEGIER: Hi, my name is Michael Begier. I'm a wildlife biologist. I'm the National Coordinator for the Department of Agriculture Airport Wildlife Hazards Program. I began working in the wildlife profession in the late 1980s. I currently have 13 years of federal service, approximately 10 of those years dealing with wildlife hazards to aviation, and I'm currently the vice chairman of the Bird Strike Committee USA.

MR. O'DONNELL: Good afternoon. My name is Michael O'Donnell. I'm the Director of Airports Safety and Standards with the Federal Aviation Administration. I've been with the FAA a year as of yesterday and before that, I was a state aviation director in South Carolina and an airport manager up in Connecticut with about 12 years of airport experience and I am a graduate of Embry-Riddle Aeronautical University.

MR. KING: Good afternoon. My name is Ryan King. I work for the FAA as a general engineer in the Airport Technology R&D Branch. Been employed in federal service for 13 years; the last three years have been, almost three years, have been in the Wildlife Hazard Mitigation R&D Program.

HEARING OFFICER BENZON: Thank you, gentlemen. I'll turn you over to Mark George now.

TOPIC 3 PRESENTATIONS

MR. GEORGE: Thank you, gentlemen, for being here this afternoon. I appreciate it. I understand that you all have presentations. I think the way I'd like to do this is have Dr. Dolbeer and Michael Begier do their presentations -- or not simultaneously, but one after the other, and then I will ask some questions to them, and then Mr. O'Donnell and Mr. King, we'll do the same procedure for you. So Dr. Dolbeer. at your leisure.

PRESENTATION BY DR. DOLBEER

DR. DOLBEER: Okay, thank you. If you'll bring up the presentation, I will begin. My objective here in the next 10

minutes is to provide this public meeting with an overview of bird strike hazards, as we now understand them in the United States related to the Flight 1549 incident. Bird strikes are an increasing safety and economic concern to the aviation industry. Economically -- and we believe these are conservative estimates -- about $1.2 billion a year in cost and US civil aviation, about half of that. And with human lives lost, there's been 229 that we know of since 1988 with a number of very close calls, such as Flight 1549. Next slide.

I think the thing of most importance, from my perspective, is that we need to look at the population status of the large bird species in North America. Now, I'm going to focus on birds that are over four pounds in weight and over eight pounds in weight, and the reason I've picked those two weights is that those are the weights that are of use in engine certification standards for large bird ingestion tests and that will be discussed at a later time by other people, but that is the reason for these two weights.

If we look at the bird -- there are 14 species in North America that weigh over eight pounds and you can see that all of those, with one exception, a species we know very little about, the yellow-billed loon in the high Arctic, have shown substantial population increases over the last 30 years. And the next slide. And if we look at the species that between four and eight pounds, there's 22 of those. Eleven of those have shown population

increases, two have shown declines, and the other nine are either stable or we don't know what their status is in terms of populations. But the important point is that of the 24 species of these large birds for which we have data, of these 36 species, 24 we know are increasing and only two are declining and in numbers. The next slide. And this is another thing that's of real importance with these large bird species, most of them are flocking birds. They're not found as individual birds, but they're found as flocks and only three of those 36 species are what we would consider solitary birds. That would be something like a Snowy Owl. The next slide.

And I'm just going to give a couple of examples of phenomenal population increases we've seen over the last 30 years. The Bald Eagle is, of course, a classic example after the banning of DDT, the pesticide, in 1972, the population has increased 20 fold. We have almost 24,000 nesting eagles in the contiguous 48 states, many more in Alaska, and these are a large bird and are becoming an increasing threat to aviation. We've had a number of strikes involving them. The next slide.

And of course, the species we're most concerned about today, the Canada goose, the resident population has increased almost four-fold in the last 19 years. The migratory population has shown a steady but less dramatic increase and the total population is now over -- about six million birds, of which two-thirds of those are resident birds and -- I mean, are migratory

birds and one-third are resident birds and resident birds means these are -- Canada geese that live year round in an area like Washington, D.C. or New York City as opposed to the migrant birds or the true migrant Canada geese that nest in the tundra areas of Canada and migrate to the United States for the winter months. But these are just examples. So we've seen this large, steady increase in populations of our larger bird species in North America over the last 30 years. The next slide.

And based on the data we have from our national database, which I'll talk about in more detail in just a minute, but we are hitting these birds with aircraft. We have, as you can see from this table right here, about 3,000 records of -- in the database since 1990 of collisions between aircraft and birds which weigh over four pounds and of those, about 50 percent of those have caused damage to the aircraft and of most concern to me is the fact that 27 percent of those incidents involved multiple birds, that last column there.

And in particular, the circled item there, for those species weighing over eight pounds, such as the Canada goose, 37 percent of the strikes that we've recorded in the database have -- of almost 2,000 strikes that have occurred with these larger species have involved multiple birds and of course, this certainly increases the probability of ingestion into both engines, our predominantly two engine fleet of commercial aircraft. The next slide, please. Now, I think it's important to

recognize that we don't want to just focus on large bird species. You know, there's over -- there's almost 700 species of birds in North America. In our database, since 1990, 381 different species of birds have been recorded as struck and 170 of those species have caused damage to aircraft and there's only 36 species that weigh over four pounds. And this is just a recent example, in Rome, of a Boeing 737 on final approach at about 150 feet, it flew through a flock of European starlings. These are bird that only weigh about three ounces or 80 grams and the plane lost power in both engines and literally crash landed on the runway and the landing gear collapsed and from what I've read from newspaper reports, it was considered a hull loss.

The aircraft is damaged beyond repair. But this is with a small flocking bird. And the next slide, please. This just shows a very similar incident that happened at Dulles Airport right here in the Washington, D.C. area two years ago or three years ago, excuse me, with an Airbus 320. Final approach at 100 feet above ground level on the runway, over the runway, flew through a flock of starlings, 270 birds picked up from the runway, and both engines were ingested.

Birds, one engine had to be removed for repair at quite a cost, but this was a very similar incident to what happened in Rome. And then finally, one last slide showing here, less than a half-pound bird, a Eurasian Kestrel, which is a small falcon, this is an American-based cargo, Colida Airlines (ph.), that aborted

takeoff after ingesting a kestrel into one engine on takeoff and overshot the runway and broken in three parts and of course, totaled the aircraft. This just happened last May and with a small, you know, relatively small bird. So it's a very diverse problem involving a lot of different species of birds of many different sizes and behaviors. The next slide, please. I'd like to briefly talk about what phase of flight and height above ground level pose the greatest risk for bird strikes, based on our database information and historic records on hull losses. The next slide.

I think you'll see from this slide, I've been able to find, through my research, 30 aircraft I consider to be the larger, turbine powered jet transport, either Turbofan or Turbojet aircraft weighing over 12,500 pounds that have been hull losses after a bird strike. And as you can see, the statistics are pretty overwhelming. Twenty-eight of the thirty of these incidences occurred during the takeoff or initial climb phase of flight.

Only one was en-route and one on approach and landing. And if you'd look at the next slide, what height above ground level did they occur? You can see that the vast majority occur on the airport under 150 feet AGL. Only three of the 30 incidences occurred above that level, one at 500 feet, the US Airways Flight 1549, at about 2800 feet, and then there was a Russian transport plane in a test flight that struck a bird at 19,000

feet. It was a very anomalous situation about 10 years ago that crashed because of -- right on penetration. But the vast majority of strikes do occur right near or on the airport, and I think this is a very important point. The US Airways incident was, in some ways, an anomaly from that point of view. The next slide. Now, I'd like to talk about the database a little bit. We've been compiling -- the US Department of Agriculture, in an inter-agency agreement with the Federal Aviation Administration, have been managing a databases since 1990 and compiling reports sent in from civil aviation and these are -- you can see the number of strikes reported has increased steadily and it's about triple now what it used to be back in the early '90s of what we're receiving.

About 98 percent of the strikes are with birds. We do have strike events and problems with deer and coyotes and a few other mammals, as well, but birds, of course, are the main concern. And the next slide.

The database has been very -- a very powerful, powerful tool in providing an overview of what the strike problem is nationally and we have put together, with the FAA, annual reports every year, going back to 1995, summarizing the data in the database and documenting the threats that wildlife pose to aviation, and the database has been very useful in guiding FAA policies on wildlife hazard mitigation efforts around airports and that area. The next slide.

And as just one example of the information that's

relevant to this hearing today, we've recorded, for turbine-powered civil aircraft, about 10,000 incidences where we've had one engine struck by a bird and we've had 500 incidences where we've had two engines struck and we've had 3,200-so incidences where one engine has been damaged and we've had over a hundred incidences where we've had multiple ingestions and two engines damaged. And we've had -- and actually, that last number, we've had 310 -- I just updated that yesterday -- 310 incidences we know of where one or more engines have had to be shut down because of a bird ingestion.

So while, you know, double ingestion such as happened in the US Airways incident are not common, they certainly have occurred with some regularity, as we've documented in the database and of course, we know the database does not capture all of the strikes that occur in the United States, so it provides -- but it does provide insight into what's going on and I think it's important to recognize, given the large bird population increases and the flocking behavior of those, that these double engine ingestions are a real event that happens. The next slide.

As far as the phase of flight, we've already talked about almost all the hull losses have occurred within airport environment where bird strikes occurred at under 150 feet. If we look at the database, we see a somewhat similar pattern, you know, 69 percent of the strikes that have -- reported strikes that have caused damage have been below 500 feet and if you look where the

US Airways flight strike happened at 2800 feet, that would be in the fourth bar from the left, that there's only been about 5 percent of the strikes that we've recorded that have caused damage to aircraft that have occurred in that height zone. So again, most of the strikes are occurring at low altitude on or near the airport environment. The next slide. Two questions which I'd like to just quickly go over, which we've gained considerable insight from the database, do bird strikes ever occur at night, and basically what we found through a detailed analysis of data in the database, that, you know, we certainly record a lot more bird strikes during the daytime, but we also have a lot more aircraft flying during the daytime.

And if you compare the number of aircraft strikes that are occurring with the number of aircraft movements in day versus night, you come up with a very interesting phenomenon. You have about an equal probability of having a bird strike at night compared to the day under 500 feet AGL. At over 500 feet AGL, you've actually got a much higher chance of having a strike at night than during the day and the lesson from that is that we have a lot of birds moving around at night and flying.

Most birds migrate at night and so this is something that we have to be concerned about. It's not just a daytime problem. And the next slide. What about time of year with strikes? Well, there's two interesting things. If you break out strikes that have occurred below 500 feet, you see a very -- and

that's the top line there -- you see a very pronounced number of strikes in late summer and this is explained by the fact that this is right after reproduction. You've got a lot of birds in the -- new birds and they're naïve birds. These are young birds that are just learning to fly. With flight strikes above 500 feet, such as happened with Flight 1549, you see there's two peaks, one in April/May, and the other in October/November, September period, and that's -- or September/October -- and that's when birds are migrating. And the interesting thing, of course, Flight 1549 was in January when we record our fewest strikes, typically.

So based on probabilities, strikes can occur anywhere, at any time, virtually any altitude and but certainly, that strike was somewhat atypical in that it occurred during the month of January, based on that. So I just -- two main deficiencies we have in the database right now are that species identification -- and this is through 2007. Of the 80,000 bird strikes, only about 20,000 were recorded identified the species or 26 percent, and an additional number of them were identified at least it was a duck or a gull or whatever. But we cannot solve a problem we don't understand and all of these birds behave differently.

The management actions we need to reduce, mitigate, these strikes vary depending on the species. Most of them are protected by the Migratory Bird Treaty Act, we have to deal with

that, so it's very important that we improve the species identification. It's useful to know if you had a bird strike, but if you don't know the species that cause that strike, the information is very limited in how we can use it. And then second, the next slide. The second deficiency in the database is that we have very uneven reporting by the airports and air carriers. And I think we get a good random sample of strikes that are occurring across the country, but it's very difficult to compare airports and their strike rates when you have some airports being very diligent about reporting and some not being so diligent. And it's in an airport's best interest that they do report all strikes and document all strikes because they need that information if they're going to develop an effective wildlife hazard management plan and mitigate those risks.

If they don't know what they're striking on their airport, not detailing it, how can they develop a management plan to mitigate those risks under a safety management system, which all airports are going under today, so these are two challenges that I see with the database. Next slide. So I'd like to just wind up by saying here is some mitigation considerations that will be discussed further by my colleagues up here.

We need to reevaluate airworthiness standards because of the large -- these population increases of these large flocking birds and the increased probability we have of multiple engine ingestions with large birds for which engines, in many situations,

are not certified to withstand and that'll be talked about by other people. But I think we've got a biological basis for why we need to reevaluate that. We need to focus wildlife hazard mitigation efforts on airports because this is where most of the hull losses have occurred and are likely to occur in the future, and my colleague, Mr. Begier, will discuss that. And let's go to the next slide, in fact. He will discuss that in his presentation shortly. And the reason, again, just to reiterate, is that most of our hull losses, if we look historically, involving bird strikes, have occurred in or very close to the airport environment -- at 2800 feet and four and a half miles from the airport. The next slide, please. We need to continue to evaluate bird detecting radar systems for use in civil aviation.

It's been used in the military under different circumstances. We know that radar can detect birds, but its use in an airport environment with ground clutter and other issues is something that, you know, we need to be evaluating that -- we are -- it is being evaluated and it's going to be discussed, but it's certainly something that can help as a tool to mitigate strikes and it's an important tool. And then finally, something we need to focus on is research on aircraft visibility and detect-ability by birds.

We know birds can see in the ultraviolet range beyond what humans can see. Are there systems we can deploy on aircraft such as pulsating landing lights, maybe of different frequencies

of wave length and pulse rates that will help birds to detect and avoid those aircraft. Birds are not suicidal. I've watched this many times. They try to avoid aircraft, they just don't see them soon enough or recognize it as a threat, and so this is an area that research needs to be done on and there's some promising things that have been done, but we need to further this. So with that, I'm finished with my presentation.

MR. GEORGE: Thank you very much, Dr. Dolbeer. Mr. Begier, are you ready to begin?

PRESENTATION BY MR. BEGIER

MR. BEGIER: On behalf of the Department of Agriculture Wildlife Services, I'd like to thank the Board for the request to come here and speak about this issue today. My main responsibility as National Coordinator is to represent the program and serve as the liaison to government/non-government agencies and then also to the aviation industry, including the private sector, regarding wildlife hazards to aviation. Wildlife Services is, I think, a little-know federal program. We're about a 1800-person program and we're part of the Animal and Plant Health Inspection Service, which is in the Department of Agriculture.

Wildlife Services' roots go back to the late 1800s with livestock protection programs, mainly in the West, but back in the '30s, Congress authorized Wildlife Services to become the lead federal agency that was available to assist the public with providing federal leadership in human/wildlife conflict

situations. And currently, the program focuses on four areas for the public: protection of agriculture; protection of natural resources, which we do with a lot of other federal programs, mainly the land management agencies; property damage issues for the public and private sector; and human health and safety. And my main focus areas are property damage to aviation and human health and safety of lives. Wildlife Services is recognized and we're tasked by multiple agencies and organizations as the lead agency that assist the public with addressing these issues. We have programmatic relationships in place through Memorandums of Understanding, some that go back quite a ways here, as you can see, with the FAA, the Department of Defense, and the National Association of State Aviations Officials.

In the late '80s, the Federal Aviation Administration recognized the role of Wildlife Services on the landscape and approached the program to provide technical and operational assistance to the administration, but also to be there as a resource of the certificated airports across the country. They also tasked us to start up a research project and applied research office that would develop methodologies and investigate different tools and techniques that could be used to reduce wildlife hazards at airports.

They also enjoined us to develop a wildlife strike database and collaborate and manage that for them. And then this Memorandum of Understanding was actually reaffirmed in 2005

between the two agencies. Similarly, with the Department of Defense, in 1990, we entered into an MOU with the DoD, and the DoD tries to avoid duplication of services when there are other federal partners that can handle situations for them and they've enjoined us to assist airbases, air stations, military facilities, with all wildlife damage issues, if requested. And then similarly, in 2006, NASAO called upon us to assist them with technical expertise, mainly land management issues around small airports, but also to investigate training issues with them. I mentioned the National Wildlife Research Center. The National Wildlife Research Center is part of Wildlife Services and is the only world-class institution that is solely dedicated to finding methods and methodologies and techniques to reduce wildlife damage issues, and the history of the NWRC goes back many, many decades into the early part of the 1900s, finding tools to assist the public.

We currently have a field station that is solely devoted to investigating wildlife issues at airports and this is located at the NASA Plum Brook facility in northern Ohio, and that facility works with the FAA through an inter-agency agreement. It also works with the Department of Defense on several projects and private industry, when the industry brings different tools that may want to be tested to see if they're efficacious.

So we're doing a lot of projects right now with DoD down at Langley Air Force Base. In the top left there, you can see

that's an osprey. We're actually doing stuff, modeling the flight behavior of osprey to develop, you know, risk profiles to the fighter jet community there. We do work with fencing. That's mainly been with private industry, how to keep animals off of airports. Foraging behavior of Canada geese, basic ornithology. Right now, with the FAA, we're enjoined in a lot of work with trash transfer stations around the country, how they attract birds; keeping earthworms off of runways; pulsating light technology. We have a very interesting project with FAA Southern Region. You can see the water containment ponds. This is a very big problem around some airports is that we have to treat water runoff, but we know that water that can be an attractant to birds, so we're working with Southern Region right now on a project that's investigating how to better construct water management detention facilities around airports so they don't attract wildlife.

And then we've also been doing a lot of work with the Air Force and the Navy on the use of small mobile radars at their different air bases. One of the things that Dr. Dolbeer had mentioned that started during his tenure at the research facility, was the FAA's National Wildlife Strike Database. And this has been one of the key foundations that's helped the industry to define this problem.

And as I mentioned before, the database is actually managed out of my office. As Dr. Dolbeer mentioned, the nature of

this problem, we really have a much better handle on this problem. When I started about 10 years ago in this field, looking at some of these reports, it gave me a better understanding, as a biologist, about what I was dealing with at the Marine Corps facility at the time where I was working, and a lot of things have come to light. We mentioned the problem with hull losses that have occurred in the airport environment and a lot of this material has been documented, it's been available to the public for the last 15 -- or almost two decades now and it's been documented in various reports and it's been peer reviewed in the scientific literature. And this is just -- I think the FAA deserves a lot of credit for standing behind this continued effort with this database because it's allowed for policy and regulatory guidance by the FAA, but like I mentioned, when I started in the profession, it allows wildlife biologists to more efficiently manage their time in how to handle wildlife hazards.

There's a lot work that's being done across the United States right now to address the issue of wildlife hazards at airports. Airports sometimes have their own staff that deal with this and manage these issues. There's private sector involvement that addresses wildlife hazards to aviation.

I think that the majority of this work right now is being conducted by the Department of Agriculture. In fiscal year 2008, USDA assisted, in some manner, 764 airports or air bases across the United States with this issue. 69 percent of the

certificated airports were assisted by our personnel and our personnel expended 160 staff years of time addressing wildlife hazards in '08 alone. And another thing that's been interesting that's been growing, and this is as a result of FAA policy guidance and advisory circulars, but Wildlife Services has developed training programs to train airport personnel -- and this has been a very natural fit for our program. The wildlife management profession has a long history of cooperative extension type outreach on various issues and our program last -- in fiscal year 2008, trained approximately 2200 airport employees across the nation in how to recognize and possibly assess these issues and that was to fulfill -- many of those people were trained to fulfill their FAA obligations.

Now, a lot of times at various presentations and discussions with the public, people say Well, how do we go about, you know, defining and addressing wildlife hazards to aviation? Now, in order to reduce the impact of these issues, it's very necessary to conduct a wildlife hazard assessment. This is a very -- this process is very widely established, assessing wildlife to find out how they're interacting with the environment. Now, a seasonably based wildlife hazard assessment can really form the basis of a well-informed plan that can address wildlife hazards. The foundation of this work at all airports throughout the world is the manipulation of habitat such that the airport is not attractive, from the start, to wildlife. We're not

doing wildlife any favors when we allow them to be at the airport. The airport is a very unique land mass that's designed for a very specific use, travel, and wildlife are a safety hazard. So we're not doing them any favors when we allow them there, so manipulation of habitat is the foundation of our work. But we also use a lot of different tools, which are very ubiquitous to the wildlife damage management profession. A lot of people have probably seen propane cannons or maybe have seen airport personnel using pyrotechnics or firework-type devices. These noise-making type devices can scare of harass wildlife from the airfield. There's been a lot of work done with hanging effigies of certain bird species around airports to cause dispersal of birds.

For instance, in the center there, that's a picture of a turkey vulture and our research has shown -- some of this research was actually done with the Air Force down in Florida -- has shown that by hanging certain species of birds, we can cause other birds to leave and then not come to the airport to begin with. There's also the use, that's used in different parts of the world and across North America, of natural predators. Many people might be familiar with border collies. There's private sector programs that use border collies to great effect and they work very well in certain situations.

The use of falconry is more established in Europe and other parts of the world than it is in North America, but the use of falconry can also be a tool that can sometimes work in certain

situations very well. Now, I have this picture up here to kind of illustrate a point, and this is an airport, probably a small GA facility, that's located in a more rural area. And one of the things that's interesting about airports is they're often located in this patchwork of habitat and we have human-made habitat, you know, the FBO, the ramp, we have ponds, roadways, housing. We have the runway, itself. So we have human-made habitat that's interspersed with the naturally occurring habitat, grasslands, forests, et cetera, and it's this richness of habitat which often provides the attraction to wildlife. One thing that we do know is that there is no single tool or technique to address wildlife hazards to aviation.

It's widely accepted by the people that do this work and in the wildlife profession that you have to use an integrated wildlife damage management approach and by that, what I mean is you have to use all the tools in the toolbox. Wildlife are very adaptable, they can get used to different techniques very quickly and you have to really change it up. And having a trained professional can also be very key, somebody who is a wildlife biologist that understands wildlife, they understand the ecological relationships of why the animals are there to begin with.

They are in a good position to employ these tools to their best extent. Now, currently Wildlife Services has over 300 people that are actually trained for FAA regulations to actually

do this work at airports and it's these trained professionals that are best suited to handle this type of work on a daily basis. I want to just do a brief description here just to show that basic wildlife damage management works and a lot of these tools that we use at airports were not invented for airport work. These are common tools to the wildlife management profession. Now, in here you can see that -- this is some Wildlife Services personnel in New York conducting a goose roundup and those roundups usually occur this time of year when geese are in the molt stage and cannot fly. Now, in 2003, an aircraft that was departing from LaGuardia had an ingestion of Canada geese and had an uncontained engine failure.

And some of you may recall, this plane diverted to JFK and landed safely. It was determined that it was the local population of Canada geese that were using a lot of the habitat at nearby Rikers Island that were part of this problem and it was determined that these populations needed to be reduced. And the results of this type of basic application of wildlife management principles are rather dramatic. Since 2004, when roundups began, there's been approximately 1200 geese, a little over 1200, that have been removed from Rikers Island and you can see that prior to the removals there had been eight strikes with Canada geese in that two-year period, from '02 to '04.

But following the initiation of the removals, there were only three strikes in the last five years and one strike within

the last three years. So this is a case where the application of good, basic work at the airport or near the airport was able to solve the problem. Now, some of the guidance I received was to talk about -- there's been a lot of discussion in the popular media about different techniques and some of these things seem funny to us, elicited laughter, but a lot of people, when we do this cooperative outreach and we talk to groups, they might -- you know, you actually get stories that say well, you know, what if we paint an owl or a scary animal on the side of a plane, you know, is this going to dissuade wildlife and the answer's probably not. Now, there is some evidence to suggest, you know, the wave lengths that birds can see that maybe there's something to be had with different types of paint or things like that, you know, that -- and that's some research that might be coming down the road. Another common suggestion following the 1549 event was maybe hanging shiny red Mylar tape on engine cowlings while planes are flying. You know, that a lot of farm fields in parts of the country use Mylar tape to dissuade birds. The tape moves in the breeze and it's shiny, attracts the birds and it's, you know, danger, leave. But that would probably turn into a FOD (ph.) hazard so, you know, that's not something we recommend.

But however, there has been a lot of talk in the media about several tools that are extremely promising. Over the last few years there's been a lot of work with different types of handheld lasers that can be used very sparingly at airports

because there are dangers with lasers and they can't be really used wantonly, but lasers are an effective tool that's come onto the scene that we use to dissuade and move wildlife out of hangars or from different structures. There's been a lot of advances in fencing, different types of fencing. There's been a lot of discussion in the media about small mobile radar and radar is a very promising tool. It's being actively used by the military right now and other federal agencies, such as NASA, and there seems to be some utility to radar. There's also this work that Dr. Dolbeer alluded to with pulsating lights. This is an area of research that Wildlife Services is looking at right now. And one thing I might add, as I mentioned before, Wildlife Services is actively engaged in a lot of research projects right now with the FAA, Department of Defense, and private industry to examine these tools.

So the wildlife issue at airports, I think -- it has been a problem for some time, it's continuing to grow, as you can see from these pictures that were taken at airports, and I think this is an issue that, you know, we really need to come to grips with and start to apply more pressure on to solve and it's going to involve a lot of different parties to make this happen. I guess at that time, I'm prepared for questions.

TECHNICAL PANEL QUESTIONS

MR. GEORGE: Thank you, Mr. Begier. First question I'd like to ask Dr. Dolbeer, a lot of good information there and a lot

of things I have questions about. There's always a distinction between migratory and resident geese and I have a question about, is one more dangerous than the other? Is one easier to manage than the other? How do they get that way, also?

DR. DOLBEER: Okay. It's a rather complex story, but basically up until about the early 1960s, almost all geese in the United States were migratory, meaning they nested in Canada in the tundra areas and migrated to the U.S. during the winter months. They were true Canada geese. Starting, actually, in the 1950s, some of the state wildlife agencies, in an effort to provide hunting opportunities, working with the U.S. Fish and Wildlife Service, took giant subspecies or the large subspecies of Canada geese which nested -- did nest up in the northern Great Plains areas, and started introducing those into many U.S. states, such as New York, Ohio, Virginia, states that never had nesting populations of geese, and these geese have adapted to living in those states.

They're non-migratory. They live there pretty much year round. They may do short-term migration, but they're year-round residents and those are the populations that have really increased and quadrupled in the last 19 years or so.

And in the migratory birds are still continuing to migrate and they nest up in Canada, but they've altered their migration habits because of the resident geese. Instead of migrating far south like they used to, maybe down into the

Carolinas and Tennessee Valley, a lot of those will stop in New York State and Pennsylvania and Ohio and hang out with the resident geese during the winter months. And so we've really messed up the natural goose population in the U.S. because of these introduced introductions of really an exotic species. So that's the basic difference between the two groups. Overall, I think the resident population is more dangerous because they're present year round. They're the birds that are most likely to end up on the airfield, itself, feeding on the grass. Geese, their favorite food is grass, by the way, which is mainly what an airport is, and so they're the more dangerous.

They're also the more easiest -- they're the easiest to manage because as Mike Begier demonstrated with the work at LaGuardia, by doing goose roundups and harassment and reproductive control and so on. So it's a species that we have to be very aggressive about for the resident population and keeping them away from airports. The migratory birds is a different story.

MR. GEORGE: The populations of large birds is obviously, from what you showed, is increasing. Is that trend expected to continue?

DR. DOLBEER: Well, you know, nothing increases forever and so I think at some point it is going to taper off. The reason for the increase is starting back in the late '60s and early '70s, we passed a remarkable set of environmental legislation, such as the EPA and Clean Water Act, Clean Air Act. We expanded the

wildlife refuge system six-fold in the United States. We've spent billions of dollars on environmental cleanup and environmental protection starting back in those critical years and -- which is a very beneficial thing. And we've seen -- and as a result of that, we've seen this tremendous rebound of populations of many of our larger bird species, as dramatically shown by the bald eagle, but many other species, as well, as I've documented. And as some point, we're going to have to -- you know, these birds are going to have to reaching a carrying capacity. I don't when that'll happen, but to date, it has not, and we are still continuing to see population increases.

MR. GEORGE: Are also birds that weigh less than four pounds, are they also increasing in population size?

DR. DOLBEER: Well, it's not -- I don't think it's as consistent as with the birds that weigh over four pounds. As I mentioned before, we have, you know, about 700 species of birds in North America of which only 36 weigh over four pounds, but many of the mid-size birds that are a threat to aviation that are -- like the gull populations, birds that weigh, say, one to three pounds, many of the water fowl species are increasing, and the smaller birds, like the blackbirds and starlings, those populations are doing very well.

And so we do have many, many of these smaller birds whose numbers are increasing because they've benefited from these various environmental programs that have been implemented. I

might add, just so -- I don't want to give people the wrong impression. Not everything is rosy in the bird world. There are a number of smaller birds, neotropical migrants like warblers, some of the grasslands, small grasslands species, whose numbers are really declining because of deforestation in the tropics and conversion of grasslands to row crops and things like that. But most of these birds are not of concern to aviation and those are the birds that are declining and unfortunately, the birds that are a threat to aviation, most of them are increasing.

MR. GEORGE: One of your slides showed that 94 percent of hull losses on turbine aircraft above 12,500 pounds occurred during takeoff roll or initial climb. That data is quite skewed. What's the theory on why 94 percent?

DR. DOLBEER: Okay, I think there's two main factors. One, during takeoff roll and initial climb, you've got the engines at full throttle and with modern Turbofan engines, the fans are -- you know, most of these have a diameter of six feet or to ten feet, perhaps, and those blade tips on the fans, the first stage of the compressor, they're traveling at over the speed of sound, 800 miles an hour, so 3,000, 4,000 RPMs.

And so energy equals one-half mass times velocity squared, so when a bird slams into that fan or a fan, actually, blade slams into the bird, the aircraft going 175 miles an hour at liftoff and the fan blade going at 800 miles an hour, you've got a tremendous amount of energy that's got to be dissipated by that

fan blade and therefore you're more likely to have engine damage during the takeoff than during the final approach when the engines are more in an idle speed, much lower RPM. The other factor relates to the last panel. You know, pilots during a takeoff, if an engine goes out, they have a lot more decisions to make in a very short period of time. It's a more -- perhaps a more difficult environment for decision making and as opposed to when you have a bird ingestion on final approach and are pretty much able to land the plane. I mean, I'm not a pilot, but I would think that's part of the answer, too, but it's speed is the main factor, I think.

MR. GEORGE: You were co-author on a paper a few years ago that showed that no more than 20 percent of known strikes are actually reported in the database. Could you comment on the methodology that you used to arrive at that 20 percent figure?

DR. DOLBEER: Okay. Yes. You know, the database is a voluntary reporting system as it's now set up and that's a question that was often answered, Well, how many of the strikes are you capturing? Well, what we did was, I would -- another author, we got a hold of data from three airlines and three airports that allowed us to look at their internal records that they maintained on wildlife strikes and we ended up with 14 sets of data or 14 years of data from those three airlines and three airports and we looked at how many strikes they had recorded in their -- and this was from the year 1991 to 2004 -- and we found

that we were only capturing about 20 percent that were of the strikes that they knew about that were ending up in the FAA national database. So that's what that study was based on.

MR. GEORGE: I can't remember, it was several years ago.

DR. DOLBEER: Yeah, 1991 to 2004, the data -- but mainly, in the late '90s were most of the data.

MR. GEORGE: Do you have any reason to believe that right now, that the reporting is any different than that 20 percent?

DR. DOLBEER: Yes. I think it's increased and -- you know, I don't have objective numbers to give you on that and it's something that needs to be revisited, but based on -- as Mr. Begier mentioned, we've got a lot more biologists working on airports today, in the year 2008 and 2009, than we did 10 years ago, helping airports develop and implement their wildlife hazard management plans and we've done a lot of promotion with posters and other -- working with the FAA and encouraging airports to report strikes. So I think because of those factors we are getting more strikes today than -- reported than we did based on this study, but the extent that we've improved, I really can't tell you the number. I know we're still missing a lot of strikes, but I think we're definitely above the 20 percent now.

MR. GEORGE: Well, that leads to my next question.

DR. DOLBEER: Okay.

MR. GEORGE: Are you a proponent for mandatory reporting

of strikes?

DR. DOLBEER: I think it's something that needs to be really studied carefully before it's implemented, if it is. My answer is I'm not sure at this point. One of the questions I would have is mandatory for whom? Is it going to be the airport operator, the engine mechanic, the airline, the tower? You know, a lot of these strikes occur and they don't even know about it, of course, until they get the plane on the ground and, you know, who's going to report that and so I think it's something that really, it's going to have to be carefully studied and all affected groups are going to have to have input into it before any -- I would hope before any decision was made on that, mandatory reporting.

MR. GEORGE: Thank you.

DR. DOLBEER: Okay.

MR. GEORGE: Mr. Begier, I have a couple for you. In addition to Wildlife Services, are there any other federal agencies that assist with wildlife management at airports?

MR. BEGIER: Yes. I would say, most notably, the Department of Defense, the Air Force and the Navy both have very robust BASH, Bird Aircraft Strike Hazard programs, that conduct a lot of this work and keep their own databases. Another partner, a very important partner, is the Smithsonian Institute, the Feather Identification Lab, another entity. And there's also a multi-agency Memorandum of Agreement that's about six years old that

involves some of the players federally that regulatory oversight over different issues that impact habitat or wildlife that may be a problem. The Department of Interior, Fish and Wildlife Service, EPA, the Corps of Engineers, the Air Force is a signatory to that agreement, so those agencies.

MR. GEORGE: Okay. You mentioned some newer techniques that may alert birds to the presence of airplanes such as pulsating lights. Are you aware of any research that's been done in that area, specifically, and what were the results of that?

MR. BEGIER: Yeah, our National Wildlife Research Center staff up in Sandusky, Ohio, has done work in that area, some of the initial science has been done by our folks, and right now the results of that work -- we know, conclusively, that light can manipulate bird behavior and we know that -- we've been able to determine that visual acuity of some bird species, that is how do they see.

Right now, the next step is going to be how do we use light to initiate a response, that is to say if an aircraft is flying -- what do you do with the light to maybe deter the bird or make the bird move away from the plane or alert the bird to the plane's presence, that's sort of the hypothesis right now.

MR. GEORGE: But there is research that's ongoing?

MR. BEGIER: Yes. Yeah, with -- actually, with private industry.

MR. GEORGE: Last question and this is kind of just out

of curiosity because I use this airport, but do you have wildlife -- Wildlife Services have biologists at Washington National Airport?

MR. BEGIER: Yes, we do. We have a staff at Reagan National and I believe that program is approximately 10 years old.

MR. GEORGE: Are there any populations of resident geese in that area that you know of?

MR. BEGIER: Yes. Yes, there resident geese are an issue at the airports in the D.C. metropolitan area.

MR. GEORGE: Thank you very much. Mr. O'Donnell, are you ready to do your presentation?

MR. O'DONNELL: Yes, sir.

MR. GEORGE: Thank you.

PRESENTATION BY MR. O'DONNELL

MR. O'DONNELL: First, I'd like to thank the Board for inviting me today. This is an honor to speak here about what the FAA is doing regarding airports and wildlife. I may be new to position in FAA but I'm not new to bird strikes, I wanted to emphasize that, that as an airport manager and the guy that used to run out there and chase the birds off the runway and file some reports, I have some passion in this area. So I want to thank the Board for allowing me to speak today.

We are doing quite a bit. I think that most of all, what we've heard today is that it's a diverse problem and that our efforts are involving many facets of aviation, both at the

airport, away from the airport, and then, of course, with technology. So what I'm going to do is quickly go over what airports are doing today on the regulatory side, certificated airports. If you'd go the next slide. We'll go over that first and then we'll go into some of the other things that airports are doing. A wildlife hazard assessment is conducted when one of these four items occur. These are called triggering events in FAR Part 139. Part 139 is basically a regulation for commercial service airports and so airports that accept commercial traffic will operate under FAR Part 139. These triggers are listed in the regulation as you see them now, so multiple wildlife strike or a substantial strike occurs, they'll have to do an assessment or if an engine ingestion of an air carrier aircraft occurs, they'll have to do an assessment.

And the last one is sort of the catchall, the wildlife of size or in numbers capable of causing any of those events listed above. So an airport, if it experiences one of those top three or -- and Number 4 is in effect, too -- then they would have to move and do this assessment. Next slide.

And basically, that's the assessment listed here, just talks about what occurred, why you're doing the assessment, what event was it that was there, the species that you saw and certainly a description of the airport, the attractants that are there, the hazards, and of course, the recommendations for reducing the hazards. Now, if it's determined that the airport

needs to do a wildlife hazard management plan, which is the next step after an assessment, this is something that the FAA makes a determination on, based on the assessment that's provided to them usually from USDA or other qualified biologists. And basically, the measures are outlined in the plan of what the airport is going to be doing to alleviate the hazards. This becomes part of the airport certification manual which is essentially an extension of the regulation of Part 139, so if they put this inside their airport certification manual, it becomes part of the regulation and what they're doing, so it allows us to help work with the airports to help them help themselves in terms of complying with the regulation. Next slide.

This is just a quick list of the authorities and the responsibilities and the things that the airports will do in a plan, but I want to draw your attention to Number 4. Number 4 is habitat management. I think that's probably the largest issue that airports deal with is trying to -- as Dr. Dolbeer and Mr. Begier mentioned, grassy areas are, by nature, an attractant to many forms of wildlife, including mammals and whatnot, so habitat management is a focus for many airports that are out there, they're trying to deal with the constant problem of birds coming back even after they've adapted to harassment techniques. Next slide.

What I want to do is back up here a little bit and talk about this -- this recommendation was made in 1999 by the NTSB

which basically had asked the FAA to consider having all airports conduct wildlife assessments as part of their 139 certificate. And I also put under the bullet there, the bottom portion of that, Bullet Number 4 has come up again because I want to kind of go back in time to '99 when this came up. At the time, in 2004, the regulation for Part 139 -- or actually in 1999, was being rewritten, so the FAA was focusing on rewriting Part 139. They didn't believe at the time that this was the right time to do it. I think that since we've looked at that, that obviously it is the time to do it, so we're moving forward with that. But I just want to nail that down today and that this recommendation is still out there, but my next few slides, I'm going to tell you what we're doing about that and we'll explain that a little more on the next slide.

Okay, before I go into why or how hazard assessments work and whatnot, I wanted to go into first what the triggers mean and what we did recently with our wildlife hazard strike database. There has been some recent stories in the press lately over what airports have had assessments and had triggers and whatnot. Here are the facts. The facts are that we've identified about 95 airports across the country that have had trigger events without an assessment.

Now, that doesn't mean that the airport may have just not done one for any reason other than not knowing about it. For example, there could've been an ingestion or a strike that the

airport was not made aware of by the airline that experienced it or by the operator that experienced it. However, we do expect the airports from time to time to check the database and they've always been able to do that. They get on the database to check it. So what we've done is we've published a Cert Alert to ask the airports -- actually, ask our inspectors to go to the airports, talk to them about these strikes, look at the database and tell us if and when this is accurate, to go back and do the assessment. And what we'll do then is constantly, almost monthly here, record this process to make sure the rest of the airports get that done. The reason why we're doing that is because we just recently initiated a rule making that require all airports to do assessments and this goes back to 1999 recommendation that was out there.

So bringing fresh eyes to this, I see an opportunity to make a real difference here with the Part 139 airports that we have today and that all of them will be required to do the assessments and then beyond that, the plans. And also, the concern you get from the other end of that is that the airports now have this mandate by the FAA to say you should do this.

We will say yes, you need to do an assessment, but we're also going to come right to the check to do it, which I think is an important note to make is that airports are eligible, most of the smaller ones, at 95 percent funding. So I think that that is an important note to make to airports as they manage their

systems. Next slide. Getting on to mandatory reporting. This was touched on a little bit earlier, but I just wanted to just kind of go over briefly -- and I'll make this quick because some of this was already mentioned. The consensus on the 20 percent is still out there; we're trying to figure out if that's an issue or not. So what we've done, I draw your attention to Bullet Number 2. We are studying the database, we're looking at the information. Not only are we going to try to find out what is statistically significant, is 20 percent significant enough to make good decisions? We've been doing that for a long time at 20 percent and it's worked out pretty good, but can it be better? Can 30 percent or 40 percent? We know it can never be 100 percent because some birds are struck and we never know about it, so -- but where is that number?

So we're studying that very carefully to figure out what statistically is significant and then make a decision at that point; okay, is the database receiving the amount of information that we need to make this happen? And I want to emphasize here that more information is good, but accurate information is better. Dr. Dolbeer pointed out that 26 percent of the strikes reported do not report species. That's very important, so if we go mandatory, you know, does it address the quality of the reports coming in, so we want to make sure that that certainly is considered.

So if we do find that reporting is not adequate, if we do find that mandatory is the way to go, then certainly the rule

making process is the preferred way to do it to allow industry involvement. But most of all, most importantly, is education awareness, whether it's mandatory reporting, voluntary reporting, much more can be done with education and awareness. This slide just kind of points out all the things that the airports need to do, regarding the wildlife situation at their airports. Not only do they have the Federal Aviation Regulations and our advisories, but all of the non-FAA bullet points there that you can read at your leisure. Of course, then you have the state policies and the local ordinances, as well. And if you recall the testimony on the Hill, the First Officer of 1549 had actually gone out and visited an airport and got a first-hand view, from an airport manager, of the challenges that they face from the multiple agencies that are involved, both local, state, and on the federal side.

I'll give you an example. As a state director, the idea of building a retention pond on an airport, for example, may be required by one agency where it now attracts birds on the airport and how do we deal with that? One idea we came up with is maybe wetland banking where these would be built somewhere else inside the same watershed, but off-airport. A lot of ideas out there, but there's got to be the leadership at the federal level with USDA and FAA to make those things happen.

So we're working very hard to do that and Mike Begier and Dr. Dolbeer are going to be a part of that in the future. That's part of our plans for the future. Next slide. All right,

just real quickly on LaGuardia. Mike talked about this earlier in that they are making tremendous progress with the mitigation efforts that are occurring at LaGuardia to this point. They have 24-hour bird patrols, bird supervisor who actually drives on the airfield. During low tide, they scrub the areas where the low tide is to check for wildlife. So there's a lot of habitat modification happening. LaGuardia's not the only airport that's doing that, but there are many others out there that are doing the same thing. The fact that this strike did not occur at 300 feet at the airport, I think is a testimony to what's going on a airports like LaGuardia where they are having effective mitigation measures. But there's more work to be done. Next slide.

This just kind of shows you what we've been doing over the years through these advisory circulars and they're being updated from time to time regarding the reporting and what attractants are at airports and whatnot. So this guidance has been out there for quite some time. Next slide. One of the things we want to do is make strike reporting easier. It's already available online, but is it easy enough, do people understand that it's there, do people know that they can actually take DNA samples or pieces of the bird and send it to the bird laboratory to get these species identified?

So we're trying to update and improve the database and make sure that it is more effective, easier to use in terms of reporting, that people can get online and report quickly and

easily. And it is existing now, but we have plans to improve it. Next slide. I want to talk really quick about the database and this picture is just, you know, an average picture of peak flying hours during the day where you have between 4,000 and 6,000 aircraft airborne over the United States. The database was never a secret database. Any airport can go to the database and say I want to see what strikes I have. Any airport can contact another airport and say hey, what do you guys have, if they're willing to share, that access was always there. But I also want to say that the database, itself, is now open to the public. The reason why there was apprehension was there was assurances made to airports all through the years, from the 1990s, that the FAA would keep the database protected from the public only in that you could not compare one airport to another and the fear was that reporting would then drop.

So when we went out to advertise for the Part 193 protection, it was an opportunity for the industry to respond. We got the response back and most of them were not so worried about it anymore. So the FAA made the decision to open the database and now it is open.

There were a few reports the following day, but the reports -- you know, people came up to us later and said this database is very complex and we understand why you care so much about it, there's so much information in there. There's a lot of information, but there's more information that can go in and we

can make it better. So we're working on improving the database. Next slide. You already saw this from Dr. Dolbeer's presentation, so I'll go through very quickly. One of the things that's not on that slide is the number of significant strikes, which has been pretty flat over the years. That tells us one thing for sure, is that the amount of reporting for significant strikes is very high, so that 20 percent that's out there, the significant strikes are a very high percentage of that. In other words, you know, if you have an engine ingestion, it's usually reported, it's higher profile; we have that information, so the substantial or significant strikes we think are reported well, but our study of the database that we're doing right now I think is going to help us look into that even further. Next slide.

This slide just kind of shows you the annual report which has been out there now -- a new one is coming out. You're going to see some changes to the annual report that we will do in cooperation with USDA, but I want to just say publicly, USDA's been a great partner since the late '80s, as we move forward with the mitigation efforts, and we're working together closely. I think over the next few months, you're going to see more things happening between not only us and the USDA, but other agencies, including the industry, as well. Next slide.

So what about general aviation airports that aren't required to have, supposedly, an assessment or a wildlife plan? Grant Assurance 19 talks about how they must, if they take federal

money, operate safely, and Grant Assurance 21 talks about compatible land use. The advisory circular is worded in a way that requires, supposedly, that airports must have an assessment if they run into these things. The problem is they're not part of the 139 requirement, so it's very hard for the FAA to enforce an advisory circular in a general aviation airport, even though it says that you must. So it's not the best wording in the AC, so how do we deal with that? Well, they still get the funding that they get every year for entitlement money and they also do come to us for technical expertise, and this is where we work with the states during the actual inspections that the states provide on a three-year cycle to work with folks at general aviation airports, as well, which we plan to approach other industries like NASAO to work on the general aviation side. Last slide.

So I just want to say in conclusion here, we understand about 73 percent of the bird strikes occur at 500 feet and Dr. Dolbeer's numbers are very close to that and these are estimates, of course, but we recognize that and we have recognized that for a long time in that since '97, we've provided over $387 million in AIP funding for airports for just wildlife mitigation projects. Most of those projects are where habitat modification has taken place.

And not only that, we funded $2.5 million annually for wildlife research programs, including the bird radar research that you're going to hear about in a minute. On the right side, of

course, we're working on identifying species; we think that's very important. The outreach plan is important, what we're doing to increase awareness and of course, this is all based on safety management system principles where we identify and mitigate the risk; larger birds, the patterns, the migration routes, times of year, things of those nature, we try to look at and apply this principle to it. So a lot happening with FAA airports, with airports, in general, and I am open to questions at this time. Thank you.

MR. GEORGE: Thank you very much, Mr. O'Donnell. Mr. King, are you ready to start?

MR. KING: I am ready.

MR. GEORGE: Thank you.

PRESENTATION BY MR. KING

MR. KING: Good afternoon. My presentation this afternoon is going to focus on bird radar and I'll present, basically -- you can put the slide up, I'm sorry. And actually, you can go to the next slide to try to make this as relatively painless as possible for everybody. I'm basically going to go over a brief history of the FAA's involvement in bird radar studies, review our current study activities, show you some examples of the bird radar characteristics, then go over some results and findings to date, and then open it up to some questions.

Radar is not new, by any means; however, the application

of radar technology specifically to identifying bird targets at civil airports is relatively new and it's really been over about the past 15 years that we've seen advancement of this technology for those purposes. The FAA's role in all of this began around 1999 when a joint effort with the U.S. Air Force was initiated to take a look to see if low-cost avian radars could reliably detect bird targets. About the same time, the Department of Defense was also pursuing similar use of radars for detecting birds at their facilities. By late 2004-2005, as a result of the DoD efforts, we had private companies that were offering commercially available, low-cost avian radar systems. The FAA decided to -- in 2006, decided to move towards evaluating those systems, leveraging the progress that the DoD had made, and evaluate those systems for use at civil airport environments.

By 2007, we had installed our first test radar system as part of our study at Seattle-Tacoma International Airport and to date, we have two additional installations of bird radar systems at Chicago O'Hare, and JFK International airports. The FAA study is intended to both assess the performance of these systems, as well identify and address any compatibility issues that may arise by introducing these into the complex airport environment. Our approach basically consists of deploying and operating these radar systems in the actual airport environments.

And then based on data that we collect during those studies, we seek, as the FAA, to produce documentation for

guidance of using these systems at the airports. And one of the most likely near-term documentation products that we anticipate would be a generic performance specification that then vendors could build to and start deploying at airports, although there are several products that we anticipate coming out. Our current project locations are up there on the map. I've mentioned them before, so I won't spend too much time on this. There is an additional deployment of test systems at Whidbey Naval Air Station at Whidbey Island in Washington State, also. I threw up some pictures here, just examples of the types of different commercial systems that are out there. I wanted to draw your attention to the size and shape of the antennas in particular.

These are not the big, you know, airport surveillance radars that you see spinning the big red antennas that are up there. These are basically marine antennas that you would see on a large yacht or a small shipping vessel. The antenna there in the upper right that looks a "T," that's commonly knows as a T-Bar antenna or a slotted array antenna, can also be known as a fan-beam antenna. In contrast to that, the two antennas in the middle are parabolic dish antennas or just dish antennas; sometimes they're called pencil beam antennas.

And the ones in the center, the parabolic dish antennas and the system pictured at the lower right are actually both bar systems installed at Seattle. If you take a slotted array antenna like the one pictured there and you spin it in the horizontal

plane, you get a detection volume, a volume of space that it's capable of detecting targets and depicted there in the red, that's a general estimate of the range of an antenna of that type. In particular, if you look at the blue wedge on the next slide -- I've drawn that up again in a little more detail -- this is a basic example of a radar beam of a slotted array antenna. They're a little more complicated than this is the way the energy dissipates to the sides, but generally speaking, the beam, the coverage volume, increased in size as the distance goes further from the radar source. And if you could slide that beam volume at any point, you would end up with a face that's a rectangle. So if you look at the light blue rectangle on the right -- and in this example, I picked six miles and this is pretty much the -- nearing the extent of the range of these types of systems.

As an example, six miles out, if a bird -- a radar beam of this type picked up, detected a bird target, what it would show on the display is a little blip in the -- showing six miles out there was a bird target detected. However, we're limited, very limited, in the information that's available on the altitude or height of that target. When the radar detects an aircraft, it doesn't tell you the altitude, it's the transponder on the aircraft that's communicating that information.

Birds don't have transponders yet. So the point of this is you can have a bird target, let's say, flying at 50 foot altitude above the ground level and one flying at nearly 6,000

feet at altitude and the only information we know is based on the dimensions of that detection area at that range, so we could say that the target is somewhere between zero feet above ground level and below the top of that, which is 1.15 miles. Similarly, the parabolic dish antennas also produce a beam that gets bigger as it gets further from the radar source. Generally speaking, it's a cone that goes out into space and on the next slide, I'll give you a little more detail of this, also. The same scenario here, as an example. Six miles out, the beam gets larger. If you slice it, in this case, the cross-section will be more of a circle rather than a rectangle and the dimensions of that rectangle will have a top and a bottom.

So this amounts to providing a better estimate of the altitude or the height information of the target acquired because you have a bottom and a top. However, the beams of this type cover much less space or volume of coverage is smaller, so you could have a target there below 1660 feet, in this example, that's not detected by that beam. Our system in Seattle uses two beams, two parabolic dishes stacked one on top of the other aimed at slightly different angles, and they give you a coverage similar to this, so the two antennas spinning essentially double your coverage volume, but they don't -- but you gain that slightly better altitude information.

Some brief results to date. I did mention -- at lease on my slide, it was mentioned that back in the late 1990s MIT had

taken a look -- MIT Lincoln labs had taken a look at using ASR-9 antennas to detect biological targets and indeed, it was discovered and it has been known for some time that they are capable with the right advanced processing algorithms to detect, with the proper filters, biological targets. However, there are still limitations in the altitude discrimination that the other antenna beams have, which I just demonstrated. They're certainly expensive and so those issues still remain with those systems. Our performance assessment study results to date are very encouraging and I think what we've done is we've demonstrated that relatively low-cost or inexpensive marine-type radar antennas, when connected to sophisticated, off-the-shelf digital radar processor units, are capable of detecting and tracking hundreds of birds in a 360 degree -- range and give you three-dimension spatial information about those targets.

They can track birds of varying sizes, from a small songbird up to a large raptor. They can operate 24 hours a day, seven days a week, which provides coverage in the night, that would be virtually impossible for a human to do, just visually. They work under a wide range of environmental conditions at ranges that, for the most part, encompass large portions of the airport property, if not the entire airport property, and they can stream target data to real time applications as well as to applications where they can be stored and analyzed at a later date.

So in conclusion, the FAA bird studies to date have been

ongoing for several years. The issues are complex and challenging, and the answers are not simple, but we are encouraged by our findings that these types of systems will play an important role and a very effective role at US airports and beyond. Like I said, I anticipate that our study will yield suitable information within a year, a year from now, to support the development of a performance specification for these types of radar systems. And we fully also expect industry to continue to advance these and other types of emerging technologies at an ambitious pace. And that concludes my presentation.

MR. GEORGE: Thank you very much, Mr. King. I'd like to ask a couple of questions of Mr. O'Donnell. What percentage of 139 airports have had a wildlife hazard assessment?

MR. O'DONNELL: The airports are divided into classes, so there's Class 1 through 4. This applies to Classes 1, 2 and 3. It's about 56 percent of those airports have a wildlife assessment.

MR. GEORGE: Okay. You eclipsed me, you answered my question about the AC-150 5200-33 Bravo. I understand that there's -- that non-139 airports there's a little less horsepower that the FAA has to exert upon them, but my question to you would be does the FAA still want non-certified airports to follow the guidelines of that AC?

MR. O'DONNELL: Absolutely.

MR. GEORGE: At an airport that has a wildlife hazard

management plan in place, how far does the airport's obligation to mitigate hazardous wildlife extend beyond the fence?

MR. O'DONNELL: It depends on what the plan says, but for most cases, the ability to impact is directly on airport property. We know that they can mitigate inside the fence. Outside the fence, it depends on what's out there. If it's the runway protection zone, then there are some things they can do, but beyond that, it's mostly working with the community to deal with the problems off-airport.

MR. GEORGE: Well, to kind of cut to the chase, considering this accident that was -- where it was almost five miles away from the airport and almost 3,000 feet, is that an area where LaGuardia should be responsible for the wildlife mitigation?

MR. O'DONNELL: No, sir.

MR. GEORGE: Mr. King, how many small radar -- avian radar manufacturers are there in your study, participating in your study?

MR. KING: Actively participating in our study right now, we're using one particular vendor for the installations that I showed you on the map there. There are three primary vendors out there that offer these types of systems, a fourth if you consider overseas vendors, and we've been in -- have been -- continuing being in talks with them about participating in our study, also.

It's important to mention that our study is not intended

to be a side-by-side comparison of the systems. They all generally operate based on similar type of antennas and we know the general characteristics of those. One of our goals is to produce a generic performance specification, so it's not a trial or test where we put radar systems side by side and see which one's better than the other. We're trying to learn what they can do and then develop some, you know, guidance documentation.

MR. GEORGE: Say I'm an airport operator and these look good to me and I want to put one on my airport. Does the FAA have anything to say about that? Would they prohibit me from buying one and installing it right now?

MR. KING: There's really nothing stopping you, as an airport operator or anyone for that matter, from purchasing one of these and operating it on your airport. You will have to comply with all the federal and local regulations and take into consideration any, you know, interference with other navigation systems and it probably wouldn't be an easy process for you, but there's nothing stopping you from doing it.

MR. GEORGE: Well, I saved the last and the hardest question of all for you. If LaGuardia or another airport around there had one of these systems, would it have prevented the accident?

MR. KING: I think the key word there is prevented. There's a lot of uncertainty surrounding that question. It's a big question to answer. I would say probably not, if these radar

systems were operated as they're configure to operate right now based on the location of the birds, depending on the antennas that we used. We can say with some certainty that the systems that are out there would've detected the geese had they been in the range where the incident took place. However, like I showed in those slides, the precision of the information that we get, the resolution of the altitude data is not what I think that we would consider actionable intelligence. We don't want to start moving, stopping, or diverting planes if there's lots of birds around at 50 feet above the ground. And the other aspect that's important to understand is when you turn on that radar, there -- I can almost say with all certainty, there's more than just that flock of birds in the area.

In that detection volume, you have birds all over the place and with the same limitations of altitude information. There are systems out there that will spin the array antenna in a vertical plane, essentially taking that fan beam, that rectangle, if you will, that was this shape, going like this -- it'll spin it like this. And what that does is it gives you altitude -- very good altitude information because your range now -- with some simple geometry can -- trigonometry -- can give you the altitude information of that target.

However, you now have a very wide swathe of coverage that could be at six miles with a 20 degree -- you know, it's -- it could be 10,000 feet or more. You don't know if the

birds -- 5,000 feet that way, which is a mile or 5,000 feet that way, but you know it's at a certain altitude. So those types of limitations are still inherent in those types of antennas.

MR. GEORGE: Gentlemen, thank you very much for your participation this afternoon and Mr. Chairman, I have no further questions.

CHAIRMAN SUMWALT: Thank you. Any further questions from the Technical Panel?

(No response.)

PARTY QUESTIONS

CHAIRMAN SUMWALT: We'll now move to the parties and Airbus, you deferred last time to go last, so you'll be first this time.

CAPT. CANTO: Thank you, Mr. Chairman. Dr. Dolbeer, just -- I was just wondering. With the increased number of bird strikes that we've seen the data, several presentations have shown, and specifically significant bird strikes, has there been a correlation -- we also realize that, for example, LaGuardia, the number of departures are at significantly high levels. Has there been a correlation between bird strikes and, let's say, numbers of departures? Just as a gauge so the pilot community can more or less hang a hat on there.

DR. DOLBEER: Yeah, we have looked at bird strikes for a hundred thousand movements, that's what you're asking?

CAPT. CANTO: Correct.

DR. DOLBEER: Yeah. And to see how that right goes. And bird strikes -- I mean, aircraft movements in the U.S. have been increasing, commercial aircraft movements have been increasing somewhere in the range of 2 percent a year with a few bumps in there with the economy and 9/11 and so on, over the last 15 years. And in our annual report that we produce every year -- and I can just quickly show you that the reported bird strikes to commercial aircraft, strikes -- well, for 10,000 movements, they -- in 1990, there were .56 strikes per 10,000 movements and in 2008 there were 1.6 strikes per 10,000 movements, so the number of strikes has increased about threefold, strike rate.

CAPT. CANTO: That strike rate, is that because the methods of reporting analysis are better or is actually because the strike rates are actually increasing?

DR. DOLBEER: Well, that's a difficult question. I think it's -- I think strikes are increasing, but also the reporting rate is increasing and to tease those two out, I cannot do that at this point for you, but I think it's a combination of the two.

CAPT. CANTO: Now, the data you just mentioned, is that for all airports or is that localized, for example, like can that data be broken down for LaGuardia or some of the higher --

DR. DOLBEER: You could, yes. This is for nationwide.

CAPT. CANTO: I see.

DR. DOLBEER: The statistics I gave you there, nationwide for all Part 139 certificated airports and commercial aviation. That does not include, you know, general aviation. But we can look at that for individual airports and it's in the database and it's accessible to anyone right now to look at.

CAPT. CANTO: Thank you. Another question, you mentioned that you had a chart where on Rikers Island, back in 2004, you did a Canada goose roundup and they rounded up -- I can't remember the number of thousands of geese and downstream there was some dramatic drops in bird strikes. Is that an ongoing thing every year, biannually, or is that just once in 2004 and not since then?

DR. DOLBEER: That's an ongoing project, annually.

CAPT. CANTO: Okay, thank you.

DR. DOLBEER: I suspect they're going to be getting ready to do that shortly.

CAPT. CANTO: Thank you. That's all I have.

CHAIRMAN SUMWALT: Thank you. US Airways.

MR. MORELL: US Airways has no questions at this time, Mr. Chairman.

CHAIRMAN SUMWALT: Thank you. CFM International.

MR. MILLS: The question we have for Ryan King is the radar technology looks somewhat promising and the question is do you have a time scale as to when it might come to fruition and then what sort of action would take place if that technology does

come into play?

MR. KING: Those are very good questions. In terms of a timeframe, we are hopeful that, like I said, our study will produce enough suitable information to produce a generic performance specification within probably a year from now. The second part of the question was what actions would take place?

MR. MILLS: Yes. What message would be given to the pilots --

MR. KING: Okay, yeah. Sure.

MR. MILLS: -- agency, or --

MR. KING: Protocols for --

MR. MILLS: Yes.

MR. KING: -- using that information? That's a big question and that goes beyond just the performance of the entire system. It's certainly going to involve other entities within the FAA and beyond, and those are things we're looking into. I don't have a timeframe on that and I certainly don't have the protocol yet, but there are certainly -- we are also, I should mention, developing KINOPS (ph.) documents, which would break down the use of these technologies for different purposes.

One is for the end user that's a wildlife hazard management -- or manager on the airport who's going to use the information in a much different way than an air traffic controller or a pilot would use the information and that's certainly a more near-term use case that we see happening. In terms of getting all

those other parties together and working out information, flow, protocols, that's a big task, but it's on the table --

MR. MILLS: Thank you very much. We have no further questions.

CHAIRMAN SUMWALT: Thank you. USAPA.

CAPT. SICCHIO: Yes. Thank you, Mr. Chairman. Good afternoon, gentlemen. A question for actually Mr. O'Donnell, initially, at least, and perhaps others. You mentioned in your presentation the reporting issue and I wonder if you could just describe the way various reports are handled in the mainstream at this particular point, in other words, different sources?

MR. O'DONNELL: I think that -- well, there's several. You have accident reports that come in from air crews and reports come in from mechanics. We have reports that come in from -- is that better? I thought it was awful quiet. I'll start over. You have reports that come in from air traffic that are reported from pilots or maybe they saw the event occur. You have reports that come in from the air crews, themselves, or the mechanics that work on the aircraft, and then you have reports from airport operators, operations people who find carcasses within 200 feet of the runway --

CAPT. SICCHIO: Okay, thank you. And the reason for my interest here is as pilots, we participate in various reporting areas and of course, ASRS is one, and most of the major carriers have what we call ASAP programs, non-reprisal reporting programs

and things of this nature. So my interest is, in attempting to manage those type of reports, what is the best way for us, as pilots, to get the information to you for your use and of course, the community at large?

MR. O'DONNELL: Certainly, the online form is probably the most convenient and the most accurate way to do it. If there's uncertainty as to the type bird, the Smithsonian Institution has the identification laboratory. We fund that every year. I think it's an educational process that maybe some folks don't know. Most airlines do, but some of the GA operators may not know or some of the other folks don't know where to go to report, so it's an online form, it's on our website. If you were type in bird strike form, it would come up as -- under Google, it would come up as one of the top bullets there. It's the easiest way to do it, it's about 15 or 20 minutes depending on how much information you have, but online is the best way.

CAPT. SICCHIO: Okay, thank you. Now, this might be -- and would anybody else care to comment on that issue on the panel?

MR. BEGIER: One of the developments -- some of these things are happening quickly, but the FAA and USDA right now are actually discussing with the industry where the mass data is pooled that you suggested, we're in discussions right now on how to streamline that data, the bird strike information, directly into the database and that's ongoing right now.

CAPT. SICCHIO: Okay, thank you. And if you would entertain just a comment from one of the end users, if you don't mind, I think -- we see with our pilots a much greater success of reporting various events with, as referred today, one-stop shopping, and the ASAP programs, for us, are very effective in gaining data in a lot of different areas, so if there is a way for the industry to use that data stream to consolidate our reporting, I believe we might get better results as an industry.

MR. BEGIER: Thank you for that information. I'll take that back to Aviation Safety and talk with them about that. Thank you.

CAPT. SICCHIO: Thank you. And one more question for Mr. Begier. You mentioned pulsating lights and so forth. My understanding is that many private aviation concerns as well as one major carrier are now using those pulsating lights, is that correct?

MR. BEGIER: Yes, that's my understanding. One of the major carriers has been working with private industry and doing some -- it would be deemed anecdotal research right now because it hasn't been rigorously tested but yeah, that is the case.

CAPT. SICCHIO: Okay, that's my question. We have no data at this time, is that correct?

MR. BEGIER: We have anecdotal data right now and there's been the field trials that our research center has conducted on the ground, but the next phase, that's going to start

occurring in conjunction with private industry and academia this summer, is taking that into the air and doing further studies.

CAPT. SICCHIO: Okay, thank you. We have nothing further and thank you all.

CHAIRMAN SUMWALT: Thank you. AFA.

MS. KOLANDER: Mr. Chairman, we have no questions.

CHAIRMAN SUMWALT: Thank you. FAA.

MR. HARRIS: Mr. Chairman, we, too, have no questions.

CHAIRMAN SUMWALT: Thank you. Any follow-up questions from the parties and Tech Panel, any follow-ups?

(No response.)

BOARD OF INQUIRY QUESTIONS

CHAIRMAN SUMWALT: Okay, we go to the Board of Inquiry and Dr. Kolly.

DR. KOLLY: Dr. Dolbeer, in 2005 you co-authored a paper on the National Wildlife Strike Database. Can you please tell me what this paper -- can you summarize what the paper found?

DR. DOLBEER: Well, can you be a little more specific on which paper because I've written quite a few. What was the topic related --

DR. KOLLY: It says, "Percentage of wildlife strikes reported."

DR. DOLBEER: Oh, yes. Okay. Yeah, that was one I mentioned a while ago. This was an attempt to answer the question what percentage of the strikes were we obtaining with a voluntary

reporting system and in that study, we looked at three airlines and three airports, certificated airports, that had maintained internal databases of air strike reports and we had 14 years of data combined with those six entities and looked at what percentage of those strikes ended up in the national database were actually reported to FAA and ended up in the database. And it was around 20 percent, is pretty consistent and that was in those different entities. And that's where we came up with that estimate of 20 percent.

DR. KOLLY: What was the purpose of trying to find out what that percentage was? What was the reasoning behind --

DR. DOLBEER: Well, under a voluntary reporting system, you know, that's a question that was frequently answered is what percentage of strikes are we capturing in the database and it was an attempt to find out where we stand and what -- and one of the reasons for doing that was we wanted to be able to project out, for example, on our -- we collect information on economic cost of strikes when it's reported, you know, the aircraft down time and cost to repair and other incidental costs like putting passengers up overnight with a delayed flight. And so in order to come up with a more accurate economic analysis of the impact and the total magnitude of the problem, we needed -- with the data we had, we needed to have an estimate of what percentage of the strikes we were obtaining that were actually occurring out there. So that was the purpose of that study.

DR. KOLLY: Did you, in that paper, or have you since used that paper to arrive at any conclusions over the thoroughness or the value of the database as it stands now?

DR. DOLBEER: Well, I have not -- no, we have not used it. Well, first of all, we've not updated that study and that needs to be done now to see, with the increased awareness of wildlife strikes and the increased efforts being made on airports throughout the country, a lot has changed in the last several years, even before this recent incident that we're talking about today, Flight 1549, and it needs to be updated. And so we have not looked at it, but as I mentioned earlier, my own feeling is that the database does provide us with a very good -- at the current reporting rate, a good overview of the problem on a national level that helps the FAA develop policies to improve aviation safety, but where it's really deficient, the two areas where we need improvement are in the identification of the species being struck because management actions vary depending on the species, and Number 2, the uneven reporting among the airports and airlines in providing us the data.

Makes it very difficult to develop and evaluate wildlife hazard management plans for airports, particularly those airports that are not reporting as well as they should, particularly under a safety management system which is data driven. If you can't define what your problem is and what your risk is, how can you manage it? And so these are the things that need to be -- we need

to get more even reporting among airports and consistent reporting.

DR. KOLLY: Thank you. Mr. O'Donnell, how is your current assessment similar or different than what Dr. Dolbeer has done?

MR. O'DONNELL: I think that we hope to look at not only the 20 percent, but also other aspects of the database. For example, the species identification, what percentages we're getting. We hope to get some more information on what other databases are out there and maybe combine them all into one super database. There are other ones out there that may or may not mimic what we have, so we want to look at what other, maybe -- engine manufacturers have databases for engine strikes that they count -- and put those all together to come up with a holistic picture of what's out there. So it's a little broader.

DR. KOLLY: And is it an internal FAA assessment?

MR. O'DONNELL: Well, it's an internal assessment is done through the tech center that will be contracted out, so that other folks from industry experts out there would be able to get involved with it.

DR. KOLLY: Is USDA involved in that?

MR. O'DONNELL: As a matter of fact, they are. Yes, sir.

DR. KOLLY: Okay. Thank you.

CHAIRMAN SUMWALT: Yes, sir. Mr. DeLisi.

MR. DELISI: Thank you. Dr. Dolbeer, when you talk about large birds flying in flocks, can you give me an idea, is there -- how many birds might typically be in a large bird flock?

DR. DOLBEER: Well, that's -- it's impossible to give an answer to that. It can vary from -- and it depends on the season of the year and the species and the situation. Canada geese, for example, during late summer you'll often have family groups, a male and female and three or four offspring, so a typical flock might be seven birds. And as the fall season progresses, these coalesce into -- you can have several thousand in a flock. But, you know, having said that, a typical flock often includes anywhere from 50 to a hundred birds would be -- you know, you might say is a typical flock, but it can really vary. And then you've got Sandhill Cranes and tundra swans and a lot of these other large flocking birds and each one can be a little bit different in their -- but generally, it's definitely -- when you say a flock like -- you know, five would be very small and a more typical flock would be anywhere from 25 to 200, something like that.

MR. DELISI: In the information that you've looked at so far that's been developed in the investigation of Flight 1549, do you have any opinion on the size of the flock that this airplane encountered?

DR. DOLBEER: No, I do not have that information.

MR. DELISI: Okay.

DR. DOLBEER: You know, all I know is, you know, what's been reported. We know it was migratory birds that bred probably in northern Labrador and -- but the number of birds that were in the flock, I do not know.

MR. DELISI: Thank you. And you mentioned something about them being migratory and I'd like to see if you can help me understand why that's important. Is there any expectation that migratory birds follow certain patterns that can be predicted and avoided?

DR. DOLBEER: Well -- yes, they can. And you know, the military right now has a bird hazard avoidance system, avian hazard avoidance system, that they deploy and based on historic migratory patterns and also based on the use of NEXRAD radar filtered for -- instead of looking at weather, looking at birds, they have a system set up where they can predict days and particularly nights during the migration period when there's heavy migration and if the Air Force, for example, is planning some training flights at 2,000 feet along the Atlantic coast on the 20th of October and it's a night with a cold front and a north wind and the radar shows a lot of birds, they can shut it down and say we're not going to do those training flights tonight.

And so there are some predictability -- ability to predict with migratory birds, but you know, not completely. I mean, these birds -- this was in the middle of January and these birds -- no one knows where they had been in the days preceding or

where they were heading to. All we know is they were in Labrador in the summer nesting, probably in October they had migrated, started migrating south, and were spending their winter somewhere up and down along the Atlantic coast. But there are some -- you know, there is some level of predictability and it's ideal for the Air Force and Navy in their training, but very difficult to integrate into commercial aviation. But it is -- certainly, they're available.

MR. DELISI: Thank you. Mr. Begier, pardon my naivete, but you talked about this program that removes birds, Canada geese, from Rikers Island. Where do they go?

MR. BEGIER: Those birds are disposed of. Typically, they're buried and that's per the Department of Interior Fish and Wildlife permitting process. There are some instances where the meat can be harvested from those birds and put into, you know, public charity or soup kitchen type situations, but my understanding at LaGuardia is that per that permit, they're buried and disposed of.

MR. DELISI: Thank you. And you mentioned several other technology or devices that might be on airplanes that might help repel birds. I don't know if you mentioned weather radar. Do you know anything about that? Is that a wives tale, that the weather radar on a airplane may disinterest a bird?

MR. BEGIER: Over the years, there's been a lot of anecdotal stories that pilots have relayed for many decades that

there may be something to, you know, we -- I've seen reports where we flipped on the radar and birds dispersed, but right now that stuff is anecdotal at best, but as Mr. O'Donnell mentioned, that is an area that there's more focus and we need to research that and track that down and define it.

MR. DELISI: Okay. And Mr. King, we're certainly very fascinated in the avian radar and thank you for briefing us on where that stands now. I think you said something to the effect that with the technology the way it is today, we wouldn't want to start diverting flights or holding flights based on the detection that we're able to do right now, is that a fair assumption?

MR. KING: Yes. And you actually bring up a point I'd like to clarify, the question that Mr. George asked about would this technology have prevented the accident that -- and I demonstrated how -- if you recall, how one vendor turns their antenna, spins it in the vertical plane, that application is typically -- I said probably not, the accident probably would not have been prevented under the normal configuration of these antennas and that is one thing I wanted to add was when they configure that antenna, it generally, typically, looks down the length of the runway in both directions. This certainly didn't happen in line with the runway, so that's another added piece of information there. And now I forget exactly what you were asking, so --

MR. DELISI: Let me go at it this way. Tomorrow and

further in this hearing, we're going to hear about what the certification standards are for engines. We've hinted at them a little bit now, but basically I think it's going to come down to the fact that a single four-pound bird going into a turbine engine, a perfectly acceptable result of that might be that the engine stops producing thrust. Now all we need is two four-pound birds, one going down each engine, and we've completely disabled a transport category airplane. We've got to stop hitting four-pound or larger birds. Is avian radar going to be the key to helping us avoid those collisions?

MR. KING: I think, in the near term, it will play a very effective role in managing the hazards around the airport, on the airport property, and I think that's the most valuable role for it right now. Even without the precision of altitude information, a wildlife manager can see, based on historical data over the last 24 hours or last week, last month, where bird activity is on his airport, his or her airport, and then they can take targeted action on those aspects of the habitat. If bird hazards happen to be in the vicinity of a radar that's deployed to look down the runway and we get precise altitude information on those targets, then I think there's a case to be made for using that information, certainly to control the traffic to some extent.

MR. DELISI: Could you envision a day in the future where there's a system around major airports that paints a 10-mile picture and gives operators an idea of where large birds are

moving across below 3,000 feet within 10 miles of an airport?

MR. KING: Yes, I have a pretty good imagination.

MR. DELISI: Great.

MR. KING: Yeah. Certainly.

MR. DELISI: Thank you.

CHAIRMAN SUMWALT: Thank you. This afternoon we've heard some very good testimony on airport mitigation programs. We've talked about natural enemies that might be there to scare the birds off, we've talked about pyrotechnics, handheld lasers, and bird roundups, things like that, but the best that I can tell, these birds that were involved in this accident didn't depart from an airport, so would these devices -- we've already heard Mr. George's question, would the avian radar likely have prevented the circumstances of January the 15th? I want to know that all of these interesting devices that are there to scare birds away from airports, would they have, anyway, prevented this accident? And I'm going to ask each person on the panel, staring with Dr. Dolbeer.

DR. DOLBEER: No, they would not, in my opinion, because this was a migratory flock at 2800 feet four and a half miles from the airport. It had, you know, no relationship with LaGuardia airport.

CHAIRMAN SUMWALT: Thank you. Mr. Begier?

MR. BEGIER: No.

CHAIRMAN SUMWALT: Mr. O'Donnell?

MR. O'DONNELL: No, but I want to emphasize, Mr. Chairman, that certainly the bird radar, as great as it is, it's not a panacea. There are many, many facets to this issue beyond, I think as you're alluding to, that affect this and our approach to this needs to be bigger than, you know, the people at this table and what we're doing. We need to include industry that makes engines, that makes airplanes, that universities that are involved in it, all these folks that are a part of transportation, and come up with new and different ways of approaching a problem that is growing. We can address it at airports and we can do a lot of things there, but you're right; out at four miles at 3,000 feet is an issue, so I think that we want to look at it from a much larger 30,000 foot perspective.

CHAIRMAN SUMWALT: Thanks. And we'll come back to that because I think that's my point. Mr. King, your opinion of the question.

MR. KING: I would say no, but to piggyback off of what Mike just said, from a research perspective, I can envision the day where you start fusing some other radar technologies together, information that NEXRAD and airport surveillance or phase to ray systems that may be going in, in the next 25 years, and the local airport base radar, when they start talking to each other and the data flows consistent, consistently handed down from one to the other and one can see -- can't see maybe individual birds, but can see a migration happening, another one maybe can see it's coming

to the airport, when they start interacting together, I think then you could start to see some real benefit for the total picture, even off the airport property.

CHAIRMAN SUMWALT: So correct me if I'm wrong here, but -- you're probably right that we need a systems approach. We need to have airport mitigation efforts to keep the birds and the airplane separated, but we need more than that. Dr. Dolbeer, would that be our opinion?

DR. DOLBEER: Yes. You know, as I presented in my talk, I think we need to not lose sight of the fact that this incident, based on historic data, was somewhat of an anomaly. Most of the serious hull losses, the hull losses, have occurred with strikes on or right at the airport environment. But certainly, yes, we need a comprehensive approach and for strikes such as this, it seems to me that the two areas that are going to help reduce the risk of this in the future are radar and enhanced visibility of the aircraft for birds.

CHAIRMAN SUMWALT: Yes. And thank you. And yes, this does appear to be an anomaly. I think we've heard that most of the bird strikes occur below 500 feet and I believe we also heard testimony -- I can't remember if it was Dr. Dolbeer or Mr. Begier -- that these -- the most -- the "most dangerous birds are the resident birds," is that correct? These were, in fact, migratory birds --

DR. DOLBEER: Right.

CHAIRMAN SUMWALT: -- so I would hate to think what would've happened that day if we would've dealt with resident birds because these migratory birds brought the airplane down. My point is there were a lot of contradictions, statistically, to what happened on that day, but nevertheless, it did happen.

DR. DOLBEER: Right. And the irony in this situation was that LaGuardia had done an outstanding job of mitigating the resident birds in the area and has greatly reduced the risk of a strike by Canada geese with resident birds, so -- but in this case, it was the migratory.

CHAIRMAN SUMWALT: So do we need -- it would seem to me, and this is a question, we need devices -- do we need devices onboard the airplanes to basically scare the birds away from the airplane, is that what I think I hear you're saying?

MR. BEGIER: Yes. I think based on some of the preliminary work that's been done, I think we should definitely investigate that work.

CHAIRMAN SUMWALT: I'm sorry, say that --

MR. BEGIER: Based on some of the preliminary stuff, I talked about pulsating lights. The industry has started to bring up the question of the weather radar again. I think we need to accelerate research in these areas and determine if these can be efficacious.

CHAIRMAN SUMWALT: Well, thank you, because to me that seems like, perhaps, a way to go. We're taking care of the

airports and keeping them off the airports, but again, we've got to be able to once an airplane is away from the airport and flying at 300 knots or 250 knots or whatever, to keep the birds and the airplanes separated, so it seems to me that there would be some sort of technology, whether it's flashing lights, pulsating lights, or lasers onboard airplanes or whatever, that airborne weather radar that can scare the birds, whatever, it would seem to me we need to be looking at those technologies and I think I hear that is what you're saying?

MR. BEGIER: Yes.

CHAIRMAN SUMWALT: Thank you. I hear two yeses from the table there and thank you. I think this afternoon -- I think, actually, today has been a fascinating day and the good news is we had talked about going until 6:30. For those of you who would like to stay -- no, I think today has been fascinating, excellent testimony. We will tomorrow, in spite of what you may have read or heard, tomorrow morning we will begin at 9:00 in the morning, just like today. We'll start at 9:00. The board room will open an hour before that, if you'd like to come in. At this point, we will adjourn until 9:00 in the morning. Thank you very much.

(Whereupon, at 5:00 p.m., the hearing in the above-entitled matter was adjourned, to be reconvened on the following day, Wednesday, June 10, 2009, at 9:00 a.m.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	PUBLIC HEARING IN THE MATTER OF THE LANDING OF US AIRWAYS FLIGHT 1549, N106US, IN THE HUDSON RIVER, WEEHAWKEN, NEW JERSEY, JANUARY 15, 2009
DOCKET NUMBER:	SA-532
PLACE:	Washington, D.C.
DATE:	June 9, 2009

was held according to the record, and that this is the original, complete, true and accurate transcript which has been compared to the recording accomplished at the hearing.

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Timothy Atkinson
Official Reporter