UNITED STATES OF AMERICA
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

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IN THE MATTER OF THE INVESTIGATION OF *
AMERICAN AIRLINES, INC., FLIGHT 1420, **Docket Number**
McDONNELL DOUGLAS MD-82, N215AA **SA-519**
LITTLE ROCK, ARKANSAS, JUNE 1, 1999 *

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Arkansas Excelsior Hotel
Bill Clinton Ballroom
Three Statehouse Plaza
Little Rock, Arkansas 72201

Friday, January 28, 2000
8:30 a.m.

Board of Inquiry

HONORABLE JIM HALL, Chairman
Board of Inquiry

THOMAS HAUETER, Deputy Director
Office of Aviation Safety

JOHN CLARK, Deputy Director
Office of Research and Engineering

BARRY SWEEDLER, Director
Office of Safety Recommendations and Accomplishments

BEN BERMAN, Hearing Officer
Office of Aviation Safety

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MARK GEORGE
CHARLES PEREIRA
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Washington, D.C.

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Little Rock National Airport

J.T. CANTRELL, Training Chief
Little Rock Fire Department

I N D E X

Airport and Aircraft Rescue and Fire Fighting

P R O C E E D I N G S

8:30 a.m.

CHAIRMAN HALL: We will reconvene this hearing of the National Transportation Safety Board. This is a public hearing in connection with the Accident Investigation of American Airlines Flight 1420, McDonnell Douglas MD-82, Serial N215AA. This accident occurred June 1, 1999, at Little Rock, Arkansas.

Mr. Berman, would you please introduce our next witness?

MR. BERMAN: I call Mr. Thomas Yager.

Whereupon,

THOMAS YAGER

having been first duly affirmed, was called as a witness herein and was examined and testified as follows:

INTERVIEW BY BOARD OF INQUIRY

BY MR. BERMAN:

Q Good morning, sir.

A Good morning.

Q Would you please state your full name and address for the record?

A Thomas J. Yager. Mail Stop 494 -- 497, NASA Langley Research Center in Hampton, Virginia.

Q And your employer is?

A The National Aeronautics and Space Administration.

Q Thanks. What is your position at the Langley Research Center?

A I'm currently a senioresearch engineer.

Q How long have you been in that position?

A For the last 13 years.

Q Could you tell us about your duties and your responsibilities in that position?

A Yes. Currently, I'm program manager on a joint international effort to look at winter runway conditions, much like we have here today in Little Rock.

This is a joint effort with the FAA, Transport Canada, NASA and several government agencies in Europe, where we're looking at airplane performance under these conditions.

I've also conducted several studies of tire performance on a variety of pavement surfaces, both dry and wet, as well as snow and ice-covered, at our Langley Track Facility in Virginia.

I've been involved in developing tire designs and pavements for use in the Space Shuttle Program. I've looked at anti-skid brake systems on a variety of airplanes, and since about 1970, I've been involved in approximately 30 aircraft accident investigations where loss of traction is a suspected cause.

Q Okay. Thank you. And cdd you please tell us about your education and training and prior experience that led you to your current position?

A Yes. I've got a Bachelor of Science Degree from the

University of Portland in Engineering Science, and upon graduation there in 1963, I accepted a position at NASA Langley, and I've been essentially working in that same division for the last 37 years, looking at aircraft ground-handling performance.

Q Very good. And do you have any FAA airman certificates or other licenses that you can tell us about?

A No, I do not.

Q Okay. Thank you very much, sir.

MR. BERMAN: Mr. Pereira, go ahead.

MR. PEREIRA: Thank you.

INTERVIEW BY THE TECHNICAL PANEL

BY MR. PEREIRA:

Q Mr. Yager, what resources and facilities does NASA have at its disposal to investigate airplane braking, landing performance, runway characteristics, etc.?

A We have several at NASA Langley that I'm directly involved in. I guess I should identify those.

One of them is depicted in the first chart. It's our Aircraft Landing Dynamics Facility. If you could bring that up on the screen? This facility is unique. It's one-of-a-kind in the world. We have a large tubular steel test carriage, weighs about a 110,000 pounds, to which we can attach a variety of aircraft landing gear systems.

The next chart or overhead shows that carriage during propulsion, and this is a view of the test track. It's 2,600 feet in length. We use a waterjet propulsion system that produces two million pounds of thrust on this carriage.

We getit up to a top speed of 220 knots in 400 feet, and then we coast through an 1,800-foot test section where we do free rolling, braking and cornering tests of a variety of landing gear systems.

We can look at different pavement treatments, different wetness conditions, including ice, with this facility.

We've got three other major facilities. I think there's one other view of this Aircraft Landing Dynamics Facility. Normally, we can make four runs a day with this. It takes about an hour to pump the water back up. We use 11,000 gallons of water.

Each test runs -- though it's quite economical in terms of water and electricity. It's only $50 a test run. So, the aviation community has taken advantage of it, and we've done several studies in support of Boeing and other air frame manufacturers and tire manufacturers as well as brake system designs.

The other three facilities that are not depicted here in charts that we have available is an Instrument and Tire Test Vehicle. It's a large truck with an instrument fixture on the back that we can perform braking, cornering and fix-slip test modes with, and that can accommodate commuter-type aircraft tires as well as vehicle tires.

We have what we call a Diagonal Brake Vehicle that's been used in several runway friction evaluations in support of accident investigations, and that vehicle is still in use, and it supported the Space Shuttle efforts, both out at Edwards Air Force Base and down at Kennedy Space Center.

The fourth vehicle or test facility that we have at Langley is relatively new. It's an Instrument 747 Airplane that we used last February in some braking tests up in Northern Michigan, and we hope to use it much more in the future years, looking at not only ground-handling performance but several of the problems related to in-flight performance.

One of the studies that's underway now is to implement a better weather avionics package that pilots can use in the cockpit as they're flying from Point A to Point B, and I know that's of concern in this accident event.

Q Okay. I understand you have a presentation on airplane braking performance and other subjects of interest to this investigation. So, if you'd proceed with that, please.

A Very good. Thank you, Charlie. If I could have the first slide, which is an overview of the factors affecting aircraft wet runway performance. I apologize for the size of the type, but I'll try and go through it one block at a time.

Basically, we have four -- four factors identified here on the left, atmospheric, runway surface, aircraft tire and runway surface again. These first two go into determining the runway water depth that's on the surface.

We must consider the rainfall rate and the wind velocity and direction. We've got to consider the slope of the runway, both from a transverse and longitudinal direction, and then what we call the macro texture of the sandpaper-type finish on the surface. These factors here influence the water depth.

In terms of the tire-pavement drainage capability, ground speed plays an important role in tire friction performance on a wet runway. Many of you are aware of the problem with hydroplaning. When you can get up to high enough speeds to develop that, that becomes a definite problem.

One of the main factors influencing hydro-planing is inflation pressure, tread design and wear. We found in tests at Langley that these are important factors to consider in terms of tire-pavement drainage capability, and then the runway itself contributes to that in terms of both micro texture and macro texture.

Having defined these two blocks, we can then go into determining the available tire-pavement friction coefficient that is influenced by both the aircraft parameters as well as the pilot inputs, his technique or her technique applying brakes and using directional control.

In terms of the aircraft, we have to deal with aerodynamics, engine thrust, brake systems and, of course, the landing gear geometry itself. All of these factors combine to come up with the eventual aircraft wet runway performance, and to date, I've been involved in studies of 13 different types of airplanes and looking at these parameters in general, and one of those types has been the DC-9 and later the MD-80.

If I could go to the next chart, --

MR. CLARK: Would you describe the difference between micro-structure and macro-structure?

THE WITNESS: Right. Macro texture is the large roughness in the surface that is visible to the eye. Micro texture is a small sandpaper type of texture that you can only feel, and I've got a chart later in the presentation that better describes the difference between macro texture and micro texture.

These two terms are not related to runway roughness. Roughness is more of a long wave form phenomena and not connected with macro texture or micro texture.

This chart here basically gives the forces and moments that are developed between the tire and the wet pavement. First of all, you've got the direction of motion left to right, the tires spinning in this direction. You have a rotational acceleration this way. You have brake torque with the braking going on.

This FW force is a combined rolling resistance, and if you have fluid on the runway, drag produced by that fluid. Now, if you raise the chart just a little bit, you can see at the bottom here that during normal operations, the -- the vertical load on the tire is not centered directly below the axle. It's somewhat aft of it.

This W being the weight on the landing gear, and the L being the lift factor, and that lift factor, of course, is influenced by the configuration of the airplane.

Having spoilers on, that lift factor is low. Not having spoilers on, the lift factor is quite high, and these two terms here go into the equation along with friction coefficient to develop the added drag force that the pilot can accomplish during braking.

Now, as speed goes up, this vertical force developed between the tire and the pavement starts to move forward, and when you get up to hydroplaning speeds, it will be ahead of the axle and cause a spin-down moment, and if conditions on the pavement persist, that spin-down moment can result in the wheel stopping and not rotating and yet the vehicle is going at over a hundred knows velocity. We've seen this in -- in films of our -- at our test track facility.

CHAIRMAN HALL: Mr. Yager, could I ask you if the -- if the -- what happens to that equation if the vehicle is sliding sideways?

THE WITNESS: That compromises the -- the situation in that with steering inputs, you take away from the drag force. The higher the steer angle or the yaw angle, the lower the drag force is that you can develop between the tire and the pavement.

It's a vector phenomena, and if you have a hundred pounds being able to be developed between the tire and the pavement, and steering requires 70 pounds, we only have 30 pounds left for braking.

This next chart shows the variation of friction coefficient developed between the tire and the pavement with what we call slip ratio. Now, slip ratio of zero is basically free-rolling. There's no apparent slip between the tire and the pavement. A slip ratio of one equates to a locked wheel condition. There is a total lock of the wheel, and you have a hundred percent slip rotation.

Anywhere in between there is considered relative slip of 20 percent versus the forward speed of the vehicle. In this area here, we consider this the front part of the new slip curve, and it's in this area here where most of the antiskid brake systems try and operate, and they try and maintain brake pressure so that the tire is developing near the new max value in this chart here.

Now, as conditions change, this new max value, .8, under wet conditions, might go down to as low as .4 and might move further out on the slip ratio curve, and I've got some later charts that will describe that development.

The -- normally, the rolling resistance of the tire between the pavement is nominally .02, a relatively low value, although this is taken into account in our equations of motion in determining the aircraft braking distance values.

This next chart basically goes through a classification of different types of runway surfaces that one might encounter, other than today. You've got dry surface or there's no moisture, standing water, present. Damp is basically less than a hundredth of an inch, and as such, if you put your hand down on the surface, you can feel the moisture.

Under wet conditions, which were part of the -- the events of June 1st, we have standing water on the surface to a depth between a hundredth of an inch and a tenth of an inch. Excuse me.

Under flooded conditions, we consider standing water on the surface that exceeds a tenth of an inch, and this can happen under moderate rainfall rates, and with those definitions in mind, I'll be showing you several charts that describe wet runway performance as well as flooded runway performance.

This is basically a chart showing two types of hydroplaning, and this is the dynamic hydroplaning, and then a third type of friction loss on a wet surface, what we call reverted rubber skidding, and the schematics here depict each one in terms of what's happening with the tire/pavement combination.

The contributing factors for -- excuse me -- wet -- for viscous hydroplaning must include a damp or wet pavement, medium to high speed, poor pavement texture and worn tire tread. The alleviating factors, if you have good micro-texture, if you have pavement grooving or if you have a good tread design, viscous hydroplaning would not occur, and another indication of viscous hydroplaning is a poor performance of the antiskid brake system.

Under dynamic hydroplaning conditions, you need a flooded pavement, one that has at least a tenth of an inch of water on it. You need high speed. In terms of the airplane inflation pressures for Flight 1420, the -- the critical hydroplaning speed was a 126 knots for spin down. For spin up, it was a 107 knots.

Low tire pressure would be a contributing factor, and worn tire tread would be a contributing factor to dynamic hydroplaning. Good macro texture, grooving, high tire pressure and good tread design would alleviate this from occurring, and we had good tread design on the tires of Flight 1420 as well as high tire pressure.

Concerning reverted rubber skidding, the third principle cause of wet pavement friction, that normally occurs on the wet or flooded pavement. High speed is required. It can persist down to low speed. Poor pavement texture is also required. Sometimes a deficient brake system can cause reverted rubber skidding, causing the tire to lock up.

To alleviate this from occurring, you need good pavement texture, grooving or improved antiskid control devices.

We could go on to the next slide. The critical dynamic hydroplaning speeds for a non-rotating wheel, which is the case you have during the landing, the spin-up hydroplaning velocity is 7.7 times the square root of the inflation pressure. With the 195 knots that we had -- 195 psi that we had in the American Airlines MD-80 airplane, that equated to a 107 knots.

For a rotating wheel, one that has spun up and is now going into a flooded portion of the pavement, the spin-down hydroplaning velocity is nine times the square root of inflation pressure, and this is the equation that most people are familiar with, but it results in a higher speed. For the accident airplane, it would be a 126 knots, and in terms of miles per hour, that equates to about a 145 miles per hour.

This chart here shows the effect of transverse grooving, which the Little Rock Runway 4 Right has, on the critical hydroplaning water depth. I've plotted the minimum water depth required between the tire and the runway on the system, and on the X axis, the water depth that actually occurs is required on the runway.

For an ungrooved runway, you don't need as much water as what you do for a grooved runway. Now, the grooved runway in this example was three-eighths by three-eighths in width and depth and on two-inch centers, which is similar to what we have at Little Rock. Little Rock is two-inch centers, quarter-inch wide, three-eighths -- three-sixteenths of an inch in depth.

Now, if you take those dimensions and put it into this chart here, the water depth required or the water depth developed on the runway that would produce a dynamic hydroplaning effect would be approximately .28 inches in depth.

This chart is somewhat busy, but it basically shows a comparison of the airplane braking performance between the 737 and the 727 airplane, and these values were obtained at two different test sites, one at Wallops Flight Facility in Virginia and the other at the Brunswick Naval Air Station up in Maine, where we did some snow and ice tests back in the mid '80s, and I'm showing the variation of the effective friction coefficient which is the total braking effort developed by the airplane with the four main gear tires on each airplane.

First is ground speed, and in the case of the 737, the hydroplaning speed was a 105 knots. In the case of the 727, the hydroplaning speed was a 112 knots, and I show, first of all, at the top the dry braking performance on both grooved and non-grooved runways for the 737 and the 727 airplane.

You see the dotted line almost directly below the dry surface is truck wetting on a -- on a grooved surface at Wallops. Now, the grooved surface at Wallops was one-inch spacing, quarter-inch wide, quarter-inch deep, and through this range from approximately 10 knots to a hundred knots, we almost saw no difference between the wet braking performance on the grooved surface versus the dry for the 737 and also for the 727 airplane.

But when we go to a non-grooved surface, we get a decrease in effective friction coefficient, less of a decrease for the 727 than we do for the 737, and there's much more of a velocity effective friction co-efficient developed between the tires and the pavement.

We go into snow-covered and flooded runways, we get even further reduction in -- in effective friction coefficient, and under glare ice conditions at Brunswick Naval Air Station, we were down in the -- almost the rolling resistance range of the -- of the airplane.

I know in talking to the pilots after making these runs on the ice-covered surface at Brunswick, they had the sensation -- it was a 2,000 foot ice section, and on either side, it was bare and dry, and when they entered the test section in the case of the 737 airplane at about 82 knots, the pilots told me the sensation was one of speeding up when they applied the brakes rather than slowing down, and they actually came out of the 2,000 foot test section doing 62 knots. So, we had to do several more runs in order to complete this velocity curve.

MR. CLARK: Mr. Yager, why is there so much difference between a 727 and a 737?

THE WITNESS: One thing is the antiskid brake system, and the second item is the tire inflation pressure. The 727 had a higher hydroplaning speed than the 737.

MR. CLARK: Okay. And do we have -- do you have that kind of data for the MD-80, where we can -- is that --

THE WITNESS: Well, I've got data for the MD-80 tires. I don't have it for the MD-80 airplane itself. I've got data for a DC-9 that we tested in early -- early 1980s with the FAA. It was a DC-9 out of Oklahoma City, and there's a NASA report documenting those tests, and they included wet runway tests on -- yeah -- on six different runways, and that can be given to the Board.

MR. CLARK: Okay. We'll do that.

THE WITNESS: Okay. This next chart shows the wet runway effects on tire aircraft braking traction, also. In this case, the airplane was a C-141 that we were operating with the Air Force, and the chart on the left not only shows the variation of runway friction coefficient with ground speed up to a 140 knots under dry conditions for grooved surface and for non-grooved surface, but also shows the effect of tread design.

A five-grooved tire with nominally a grooved depth of two-tenths of an inch versus a smooth tire that doesn't have circumferential grooves, you do get an appreciable difference in the friction coefficient developed.

Now, this ATD value here of -- indicates the average texture depth, and similar measurements were taken at the Runway 4 Right here at Little Rock, and with the grooving, our average texture depth was .055 in the clean concrete area in the middle of the runway.

As you can see, with the one-inch spacing, quarter-inch width, quarter-inch depth, you get a somewhat higher average texture depth of .067.

Now, in terms of antiskid efficiency, basically what we're plotting here is the efficiency versus the runway traction coefficient. Again, this is related to the effect of friction coefficient, and there's two things here.

One, as the speed increases, the efficiency goes down somewhat, and as the friction level between the tire and the pavement goes down, so does the efficiency level of the antiskid system.

That's one of the dilemmas that the antiskid manufacturers face in that they've got to accommodate a high-friction dry surface, and at the same time have the system capable of accommodating a low-friction icy surface, and in many instances, that's hard to -- to reach an adequate compromise.

This chart here depicts pavement surface characteristics, and I alluded to it earlier when I was talking about the difference between micro texture and macro texture.

The first surface here is smooth like a billiard surface. You don't have any micro or macro texture. Under damp conditions, the ability to alleviate low friction or slipperiness is poor in both damp and flooded conditions.

As you go up in micro texture and macro texture, you get better and better ability to alleviate damp conditions and flooded conditions, to the point where the last two surfaces, transverse grooves and the porous friction course, some people refer to it as popcorn mix, you get excellent damp conditions, alleviation of slipperiness and also under flooded conditions, very good drainage, and that's the name of the game with the grooves and the porous friction course, is to minimize the amount of water that can be collected between the tire and the pavement as the tire passes over it during the landing or take-off roll.

BY MR. PEREIRA:

Q Mr. Yager, could you go back to that slide and point out which one of those would be similar to the Little Rock runway?
A Sure. It would be this one right here, similar to the Little Rock runway.
The micro texture was above average, and the grooving was satisfactory.
Q Okay. And could you have them zoom in on the grooved image for that one, just to show the --
A Micro --
Q -- micro texture on the top surface there?
A And basically we're talking about the -- the sandpaper texture between the grooves, and this is something you can feel as opposed to actually see.
The porous friction course is basically that. It allows water to drain vertically down to a subgrade that is non-porous, and then the water drains out to the side from there.
Okay. Move on to the next one. This is an attempt to show the effects of this surface texture and speed on the ability of a tire to develop friction coefficient on a wet pavement.
MR. CLARK: Mr. Yager, before you get to that, would you describe the -- kind of the -- the real-world effect of what friction coefficient means, such as the friction coefficient of .5?
THE WITNESS: Right. A friction coefficient of .5 in terms of airplane braking performance is exceptionally high. You would only get that under low speed dry pavement conditions.

MR. CLARK: Okay. What I was referring to was if I had a friction coefficient of .5 or .4, what -- what does that -- what would I feel in the airplane?

THE WITNESS: Oh, okay. If that was the only thing slowing you down, you didn't have reverse thrust, aerodynamic drag, rolling resistance, you'd probably feel approximately .3 gs on your body in deceleration level.

MR. CLARK: If the friction coefficient was .5?

THE WITNESS: .4 or .5, right.

MR. CLARK: And field .3?

THE WITNESS: Yeah.

MR. CLARK: A third of a g-d cell?

THE WITNESS: Right.

MR. CLARK: Okay.

THE WITNESS: Right.

MR. CLARK: All right.

THE WITNESS: Okay. Getting back to this chart, there's actually four different surfaces depicted here, and we go through a speed range of 25 to a hundred knots.

Of course, at the low speed, we get our highest friction values, and at the higher speeds, since the surface is wet, and we're operating a smooth tire that has an inflation pressure of a 140 psi, we -- as we go up in speed, we decrease the average friction coefficient because the smooth tire cannot handle the water being introduced into the front of the footprint, and as we go up in texture depth, though, this accommodates less water -- as the texture depth goes up, there's less water influencing the tire footprint contact area, and, so, with higher texture depth, we get higher friction values, basically, and again as I mentioned for the Little Rock airplane accident, Runway 4 Right had a .055 average friction texture depth value. So, it's way out here in terms of this plot here.

The rubber-contaminated surfaces at either end of the runway produced on the average of a .047 value on Runway 4 Right.

MR. CLARK: The chart you have shows 140 psi, and I thought you mentioned earlier the MD-80 tire pressure was 195?

THE WITNESS: That's correct. It had a higher tire pressure.

MR. CLARK: How would that affect -- can we get a chart generated that would reflect that tire pressure?

THE WITNESS: Yes, I could. Based on --

MR. CLARK: Generally, how would that affect this graph, if we were to use 195?

THE WITNESS:Well, I can give you a quick relationship. The hydroplaning speed for a tire inflated to a 140 psi would be a 106 knots, whereas a 195 psi, the value's a 126 knots. So, you could expect approximately a 15 to 20 percent improvement with the tires on the MD-82 versus this particular tire.

The other factor that you've got to dial in, though, in terms of how well the tire can develop friction forces is the tread design, and the particular chart that I just showed was with a smooth tire, and with the treaded tires that we had on the MD-82, I suspect that the friction coefficient based on the average tread groove depth there, it would increase the values another 15 to 20 percent. So, we'd probably see an overall improvement of 40 percent versus the values that were on that chart.

MR. CLARK: Okay.

THE WITNESS: It would be higher.

MR. CLARK: Yeah. I think if it's possible, we'd need to develop those specific curves to the specific --

THE WITNESS: Okay.

MR. CLARK: All right.

THE WITNESS: Moving on to the next one, this shows a large number of runways that I've measured personally myself, both here in the United States as well as in Canada and over in Europe, and I've divided the runways up into five different types, starting with A, going down through E.

A being the non-grooved low micro texture/low macro texture surfaces, and then as you increase maximum micro texture, you proceed on down to the Type E, which is deep grooved surfaces and open texture surfaces, and the scale here at the bottom is logarithmic, and going with that scale, our Runway 4 Right at Little Rock is in this area here.

It's definitely a Type E excellent macro texture surface, and the drainage measurements that we took in November indicate the cross slope is also very uniform and provides good drainage of the water from the center line down to the shoulder.

The next chart shows another effect, I believe, of -- of how texture influences tire friction performance. Okay. This is how texture influences the amount of rainfall that a given pavement can handle during a rainfall event.

What I've plotted here is the rainfall rate in this case in millimeters per hour, over here inches per hour, versus the pavement macro texture depth at the bottom, and then I've got curves for each transverse or cross slope that's normally found on different runways around the world, starting at a quarter percent slope and going up to two percent slope or crown on the runway.

Now, we took transverse slope measurements at Little Rock, and we determined the average slope to be 1.42 percent or very close to the 1.5 percent that's on the Little Rock Airport layout, and using this 1.5 percent, if you come into this plot at the .055 value that we measured in terms of texture, go up to 1.5 and then across, you can find that that surface, 15 feet from the runway center line, can accommodate about a 1.6 inch per hour rainfall rate.

If the surface had been grooved to, say, a one and a half inch spacing rather than two inch, and it was a quarter inch wide/quarter inch deep, which is the current FAA advisory circular recommendation, the value would have moved up to 0.62, and with the same slope, we'd be close to a two inch per hour rainfall rate that that runway could accommodate.

As most of you are aware from the testimony yesterday and the day before, the Flight 1420 touched down just slightly right of center line, 5,200 feet from the end of Runway 4 Right, and in that area, due to the crosswind coming from left to right, there would be less than a tenth of an inch of water in that area of the runway, and under those conditions, and with the high vertical sink speed that he touched down at, I have no problem or no question about the wheels spinning up on touch down.

This equation here is somewhat conservative. Since we established these curves for the five different cross slopes, we found in later measurements that there might be a need to adjust these curves upward, and in fact as much as 20 percent on some readings that we got at the Kennedy Space Shuttle Landing Facility in Florida, and I'm working on coming up with some new curves here, and with these new curves, the .055 value might allow us to get better -- to accommodate more than two inches per hour rainfall rate.

This curve again shows the influence of tread depth on tire friction performance. Again, it's friction coefficient versus ground speed, and we've got a five-grooved ribbed tire. The water depth is three-tenths of an inch. The inflation pressure's a 150 psi. The hydroplaning speed in this case is a 110 knots.

With the ribbed tread tire, you can develop over .4 friction coefficient. With the smooth tread tire, you're down to .3 and rapidly decreasing with increasing speed.

Speed plays a major role in wet pavement performance, but under snow and ice conditions, it's not as dominant a factor. It turns out that even at low speed on an ice surface, you can develop -- you can develop friction coefficients of less than .1.

This chart here shows the influence of ground speed on braking distance of -- in this case, it was a Conveyor 880 airplane, and we were looking at both smooth and grooved concrete surfaces, full antiskid braking, and the solid line on the left here depicts the dry stopping distance with brakes applied at a 130 knots, and we get about 1,700 feet of stopping -- total stopping distance.

This was on both a -- this was on a smooth surface, a non-grooved surface. If you go out here to the dashed line, this is on a wet smooth surface, one that had a hundredth of an inch water depth, and the stopping distance goes up to 2,800 feet.

On a slush-covered runway, half-inch deep, the tires were hydroplaning, and it was a smooth surface. We almost tripled the stopping distance going out to 4,400 feet.

On a wet grooved surface, however, these grooves, by the way, were one inch spacing, quarter inch wind, quarter inch deep, we almost get the same stopping distance as we get on dry, 1,800 feet versus 1,700 feet, for this Conveyor 880 airplane, and again the inflation pressure was a 150 psi.

In analyzing different aircraft antiskid braking systems, these are some of the major players in, first of all, when you can expect normal behavior, and, secondly, when you can expect abnormal antiskid operation, and when high wheel spin-up accelerations occur on a medium -- on a high to medium runway traction surface, early spoiler deployment at touch down, you can expect normal antiskid operation.

Now, in the accident event, we did not have early spoiler deployment, and hence we can expect abnormal antiskid operation, and in certain instances, when the airplane touches down on a flooded surface, you don't get wheel spin-up, and when that occurs, pilot brake application before wheel spin-up gives the antiskid system a false velocity reference, and it won't be as efficient as it would be if the wheels were fully spun up synchronous to the ground speed of the airplane.

Typical antiskid operation anomalies include loss of touch down protection, what we call brake wheel ratcheting, which is a high cycling of the brake pressure causing fore and aft motion of the landing gear and then loss of locked wheel protection, and these three anomalies equate to a loss or lack of adequate ground speed reference.

The current black boxes that control antiskid operation, most of them are tied into a wheel velocity or a wheel slip speed for the braking wheel.

This is one of the anomalies alluded to in the earlier chart. Loss of locked wheel protection. Normally, when you're coming in for a landing, you do not want the wheels locked due to brake pressure, and, so, most systems on present-day airplanes have this protection.

But under braking conditions -- what I show here is the braking traction coefficient variation with the ground speed, and one can expect on a wet runway -- wet runway condition, the maximum level of braking that you can develop is depicted by this solid curve, whereas the minimum level is depicted by this dashed curve, and with normal antiskid operation, you should be able to develop friction coefficients within this band width as speed varies from, say, a 110 knots down to your taxi speed.

But when the airplane touches down, and the wheels do not spin up or you get into what we call reverted rubber skidding, which I discussed earlier, the coefficients stay low for the entire run-out of the airplane on the runway, and in some cases, it will run out of runway length before he comes to a stop at this low braking friction coefficient.

The -- the other factor that enters into, of course, the braking equation is the effectiveness of reverse thrust, and that helps out quite a bit on low friction surfaces in stopping the airplane before the end of the runway.

This last chart shows an effect of both braking and steering on the forces developed between the tire and the wet pavement. At the top, I show braking friction coefficient versus slip ratio. Again, zero slip ratio is free-rolling, one is locked wheel, and at the bottom, the variation of cornering friction coefficient with slip ratio.

The dilemma with antiskid control systems is that to preserve braking, the antiskid must operate at increasing slip ratios as the airplane yaws. At zero degrees yaw, we can get maximum or peak braking at a relatively low value of slip, but as the yaw increases, this maximum value of braking occurs at a higher slip, and the magnitude of it is reduced, due to the fact that some of the forces developed between the tire or a component of the force developed between the tire and the pavement has to go into steering, and to preserve cornering, the antiskid must operate at low slip ratios.

As you go up in slip ratio, the cornering capability of the tire decreases, and in terms of just four degrees, it can reach zero at about 50 percent slip. At 16 degrees yaw, it would reach zero at a locked wheel condition. Of course, if you've got a locked wheel condition, you're not going to be developing any cornering coefficient under wet runway conditions.

It's this type of behavior that was obviously present in the landing at Little Rock. As the video depicted on Wednesday, he was drifting right shortly after touch down. He was able to recover from that right drift, went across the runway and then went into another yaw angle attitude with both main gears off of the runway and then went off the end of the runway under a combined yaw angle of the airplane with -- with braking.

That basically concludes my presentation on tire/pavement wet friction performance.

MR. PEREIRA: Thank you, Mr. Yager.

BY MR. PEREIRA:

Q On the slide where you discussed the various friction levels for the different speeds, and we talked about tire grooves improving that performance on wet runways, what effect would the yaw angle have on the ability of the tire grooves to penetrate the water?

A As you increase yaw angle, the frontal area of the tread grooves diminishes due to that yaw angle, and hence their ability to relieve the water from between the tire/pavement -- tire tread and the pavement would be diminished.

But going up to a high as 20 degrees yaw angle, that deterioration would be in the order of about 10 to 12 percent, if you just look at the geometry of the tread and those particular yaw angles.

Q Okay. Thank you. You mentioned the surface texture of the accident runway was among the best in the United States.

How does the runway compare with others in the United States with respect to all parameters of concern, such as measured wet friction, crown, overall water drainage capabilities, and its general ability to prevent hydroplaning and other braking problems?

A There are several factors involved here, not the least of which is texture and cross slope. We found in our measurements back in November that were taken every 500 foot increment down the runway that the cross slope is -- is very uniform. It -- it provided drainage numbers of water going from the center line to the shoulder that were quite reasonable and not lengthy until you got to the portion of the runway that was non-grooved, which was the last 13 feet before the edge of the runway, where it slowed down somewhat.

But compared to other runways where I've measured similar type drainage characteristics, it's equal to or better than some of these. It's not equal to the shuttle runway in Florida, but it's equal to several other runways that I've looked at.

Secondly, in terms of friction, we had what we call a surface friction tester come up from Dallas-Fort Worth a couple days after the accident, and he took measurements with that device at both 40 and 60 miles per hour, and the numbers from those -- those tests -- which he did, by the way, made a run on the left side of center line and then made a second run on the right side of center line, approximately 10 feet off of center line, which is in the neighborhood of where the main gear would be if the airplane stayed on center line.

At 40 miles an hour, he averaged .68 friction coefficient. At 60 miles an hour, he averaged .56 friction coefficient. The drop from 40 to 60 was nominal. I've seen non-grooved runways go from a 60 to 70 reading at 40 miles an hour down to as low as 20 at 60 miles per hour.

So, the drop here was not that great, and it's attributed to the fact of the high macro texture on the grooved surface that we have at Runway 4 Right in Little Rock.

The -- the tester, by the way, provides what's called a self-wetting feature, where it puts down 400ths of an inch of water ahead of the test tire, and the tire itself is operated at 12 percent slip or near the peak of this new slip curve that I showed earlier, and it's a fairly -- it's a very reliable device. It's been in operation now for nearly 15 years, and approximately 45 different runways around the world use this particular device for monitoring runway friction performance.

Q Okay. So, in terms of its -- again, in terms of its general ability to prevent hydroplaning and other braking problems, would you say it's good or bad?

A I would say it was excellent.

Q Okay. Is there a Federal Aviation Regulation or advisory circular that specifies what Runway 4 Right's measured friction should be, and how does Runway 4 Right's measured friction compare to other runways? Actually, I think you just mentioned that, but --

A Oh, okay. We got a picture of the solid friction tester that was used in the test back in June, and the test tire here is driven off the rear axle of this vehicle, and this is one of the vehicles we use in our winter runway friction program.

Getting back to your question, I have a chart here of the current FAA Advisory Circular 150/5320-12C, which is dated March 18th, 1997, and it shows seven different friction testing devices and what their friction levels should be for three different runway conditions.

If I'm not mistaken, the runway at Little Rock was constructed in the late '80s, and there was another advisory circular in existence at that time, which only had four of these ground vehicle devices listed.

Here, we have the KG Law runway friction tester, which is a minivan device. The skidometer, which is a trailer device. The airport surface friction tester, and the airport technology safeguard friction tester are basically both Saab vehicles, similar to the picture that was just shown.

The grip tester device is from Scotland. It's a trailer device. The tetra is from Czechoslovakia. It's a car equipped with the fifth wheel that measures friction, and then the norse meter runner is a single-wheel trailer device, and at 40 miles per hour, and at 60 miles per hour, the minimum friction levels are indicated in the chart. Minimum under the self-wetting conditions are listed first, and then for maintenance and planning, you want to have at least this level, and for new design or construction, you want to have this level here.

Now, with the runway at Little Rock, testing with the surface friction tester, like I say, at 40 miles an hour, we got .67, and at 60 miles an hour, we got .56. So, -- excuse me. At 40 miles an hour, we got .68 with the Saab friction tester, and .57 -- .56 with -- at 60 miles per hour.

So, this does meet the current FAA advisory circular requirements.

Q Okay. And in terms of that advisory circular, what you're saying there is that somewhere between the maintenance planning and the new construction --

A That's correct.

Q Okay.

A Right.

Q Okay.

A A lot of runways use these ground vehicle devices to determine when they should remove rubber deposits on the end of runways.

Q Okay. And is it mandatory that airports monitor these values and adhere to those criteria in terms of planning for maintenance once it reaches those levels?

A Right now, it's just a recommendation by the FAA. There's no mandatory requirement for any airport to perform these friction measurements.

Q And do you think it should be mandatory?

A Yes, I do, because the accuracy and the fidelity of the equipment has improved to the extent that they are quite good in determining the friction levels.

Q Thank you.

CHAIRMAN HALL: How much does it cost? You have to buy one of those things or you rent them for a test?

THE WITNESS: You can go both -- both directions. The KG Law runway friction tester, I know, performs surveys for a variety of airplanes and is under a contract agreement. To buy one, they can run as much as a 150,000 per unit. The lowest-priced one is in the neighborhood of $30,000.

CHAIRMAN HALL: And how often are -- should you take that rubber off the runway on a normal airport?

THE WITNESS: Right. On a normal airport, once a year, usually in the Fall. The FAA has guidelines in this same advisory circular that based on traffic volume, you should remove the -- the rubber on a regular basis.

Now, some of the high-volume airports, such as Chicago, JFK and Atlanta, they can be removing rubber every two or three months.

BY MR. PEREIRA:

Q And are those rubber removal -- are they requirements or are they just recommendations?

A Again, they're just recommendations.

Q Do you think that should be mandated, also?

A Well, it's certainly would enhance the friction capability between the tire and the pavement, not having that rubber filling in the voids and reducing the macro texture.

Q Thank you. Can you again summarize the condition of the accident airplane's tires with respect to the inflation pressure, the tread design, the tread wear, and how do you think their condition would have affected the braking performance of the airplane?

A In general, their tread groove depths were better than average. They were in the neighborhood of 30 to 40 percent worn. Now, inspecting them at the accident site, three out of the four main gear tires were cut or abraded to the point where they no longer were inflated. There was only one tire still inflated to a 195 psi.

In observing the tread condition around the circumference, I -- I saw no evidence of tread reversion or reverted rubber skid patches. The tread depth itself was in the order -- on all four main gear tires was in the order of .2 to .25 inches in depth. They were four grooved circumferential tread design with a wide center rib which is typical of transport airplane tread designs. They were bias ply tires. They were not radial belted tires, such as some of the newer equipment is using.

From the standpoint of what I observed on the accident airplane tires at the -- at the scene back in June, they should have developed high to excellent friction on a -- on a wet runway because of their tread condition.

Q Okay. And you mentioned bias ply versus radials. Would the radials offer any better wet braking performance than the bias?

A No. Our testshave shown that radial tires, such as some of the 777 equipment flies, from a braking standpoint, they're comparable to bias ply tire. What you gain with radial tires is somewhat better cornering capability and somewhat better wear performance. You get about 20 percent more landings with a radial tire than you do with a bias ply tire, and again that's due to stiffness.

Q And would that better cornering apply to wet and dry or just dry on the radial?

A It would apply to actually both dry and wet for a radial tire.

Q Okay. Thank you. Would you please explain the characteristics of the tire marks we found on the runway, and why we didn't find black rubber tire marks?

A Right. Obviously the pavement surface is wet, and being wet, there were no black marks evident. The marks that I observed on that runway were basically scrub marks due to the high pressure between the tire footprint and the wet pavement.

If -- under those conditions, we got this lighter appearance surface in the tire tracks versus the surrounding concrete area that was somewhat brown in coloration, and that persisted most of the way down the runway until, well, the two main tires went off the left side of the runway.

We've taken several photographs of these marks, but it's hard to -- to discern them in photographs because of the light angle, but they were definitely visible on the surface, and the fact that, first of all, they were present indicates to me that some forces were developed between the tire footprint and the -- and the wet pavement, and, secondly, --

Q Tom, they've --

MR. ZWINGLE: Excuse me. Mr. Chairman?

CHAIRMAN HALL: Yes, sir?

MR. ZWINGLE: Would the witness identify this photograph, please?

CHAIRMAN HALL: Yes, and while you're at it, Mr. Yager, for the benefit of the audience, you might try in layman's terms as much as you can to explain what you mean by "scrub mark".

THE WITNESS: Okay. Basically, it's a cleaning of the surface compared to the -- what the surface looks like immediately outside of these tracks, and visually, it's a -- it is like a scouring or a white-appearing track on the pavement that is lighter in color than the adjacent areas either side of the tire mark.

In that photograph there, you can just barely make them out. This is looking down Runway --

CHAIRMAN HALL: And this is the Little Rock runway?

THE WITNESS: That's correct. The Little Rock runway.

BY MR. PEREIRA:

Q Tom, could you try to point those out, if you can see them from there? I believe on the right-hand side there, there's two light -- there you go.

A Yeah. Right -- right in here are two of the white marks or scrub marks that I'm indicating coming from the main gear tires, and it's interesting to note that we not only got marks from all four main gear tires, we also got similar marks from the two nose gear tires, and hence this isn't due just simply to the braking action between the tire and the pavement, it's due to the steering forces being developed between the tire and the pavement.

Q Did those marks lead all the way up to the marks going through the grass and to the accident site?

A They did, and in fact, in some cases, they went across the 500-foot paint marks that delineate the first 1,500 feet of the runway, and our first -- well, I forget now what the increments are, but they're 500 feet apart, and some of those paint marks are surrounded by black paint as well as white paint, and in looking at those areas where the tires went across the black paint, you got a shiny appearance on the black paint, like it had removed the oxidized material from the paint, whereas right outside the tire track, the paint looked somewhat opaque and dull, but right in the wheel track on the black paint, it was highly glossed in a bright appearance.

MR. PEREIRA: The Allied Pilots Association, I believe, asked for identification of that picture. I believe it was supplied to us by American Airlines from some of their helicopter runs.

MR. ZWINGLE: The point I was trying to make is that the marks that Mr. Yager were referring to were not clearly visible, and I'm not certain they were visible to the back of the room, and that the -- the dark black skid marks were not from the accident aircraft. Those skid marks would indicate some type of traction of some --

THE WITNESS: Right.

MR. ZWINGLE: Okay.

THE WITNESS: Yeah. That was in an area near the touch down of the runway, and hence those other black marks were present.

MR. ZWINGLE: Thank you.

MR. CLARK: Mr. Yager, the black skid marks would indicate what?

THE WITNESS: Would indicate high friction where the sacrificial member is now the tire rubber, and it's being deposited on the pavement.

MR. CLARK: Do you get that on a wet runway or dry runway?

THE WITNESS: You get that on a dry runway.

MR. CLARK: All right.

THE WITNESS: Right.

BY MR. PEREIRA:

Q You touched on it briefly, but could you again summarize the effect of yaw angle on an airplane's breaking performance, and does NASA have simulation tools to estimate these effects?

A Yes, we do. We use our Aircraft Landing Dynamics Facility primarily to look at these effects. If I could go back to Slide 18, I believe it is, in the exhibit, where it shows the variation of friction coefficient with slip for purely braking and combined braking and cornering.

These curves here were developed from test runs made at our track facility at Langley, and we've subsequently used this data to implement a tire modeling program to use on the simulator at Langley, and also in the mid-'70s, we used it on a simulator out at Long Beach to --

to duplicate DC-9 performance, and I know in the tests out at Long Beach, where we had a variety of dry, wet and flooded runway conditions, including patchy runway conditions, we had available to us several American Airlines pilots that flew the simulation, and several other airline pilots that had thought the modeling of the friction coefficient was quite good.

And again, when you have a demand for cornering, it's going to compromise your ability to brake and vice versa.

Q Okay. Do the rainfall, surface texture and runway crown data indicate that some portion of Runway 4 Right may have been flooded, and, if so, how deep would the water have been? Could it have caused hydroplaning, and do the rest of the data that we have indicate that it did cause hydroplaning?

A Okay. Based on the parameters of wind speed and direction, the transverse slope and longitudinal gradient of the runway, the macro texture of that that were measured, I feel on the right side of center line, in the pilot's position, there would not be enough water to sustain dynamic hydroplaning.

Now, on the left shoulder, which is the upwind shoulder of the runway, due to the wind effect of stacking the water, in other words, with the runway crown being the peak, and the wind trying to hold the water on the runway, you're going to start developing an appreciable water depth on that left side.

In particular, in that 13-foot area that is not grooved, that portion could have supported dynamic hydroplaning, but the evidence on the runway where the airplane was traveling in that area down near the 1,000 foot remaining marker, and just prior to the two main gears going into the grass, we still have the white marks.

So, for some reason, in that particular area of the runway, we didn't have the water depth necessary for dynamic hydroplaning.

Q And the grooving on the tire would help alleviate that?

A Would help alleviate that. That's true.

Q Okay.

A And, of course, at that area -- area of the roll-out, he was down close to a hundred or 95 knots -- I believe he exited the runway at 90 knots. So, he was below his critical hydroplaning speed.

Q Okay. Should runway conditions, such as you just mentioned, be monitored and reported to crews, and, if so, how could this be done?

A I definitely feel runway conditions should be monitored and should be reported to the crews operating on the runways, not only those landing but those taking off that might have a need for a rejected take-off.

This can be done visually, and it can be done on the basis of weather activity. I mean if you have a period of time where in the summer months, there is no appreciable precipitation, the frequency of these inspections doesn't have to be as much, but, in addition to visual inspections, I think in terms of knowing if you have any ponding problems on a runway, you should also take friction measurements with some of these ground vehicle devices.

They do give reliable and repeatable data, and the normal mode of operation is to go the entire length of the runway, and then give values for each third of the runway, so that you have a value for the touch down area, the middle braking portion of the runway, and then the roll-out area at the far end, and having those three relative friction values does give the pilot some sense of appreciation of how good his stopping capability's going to be if he has to go with full brakes.

Q Are there automated systems, sensors in the runway, that can provide this information to the tower?

A There are some sensors available now to airport operators and also highway maintenance people that detect the presence of water, the presence of ice on a pavement surface. They will also indicate temperature, and the newer ones will indicate depth, and if I'm not mistaken, Runway 4 Right, 22 Left at Little Rock, has two of these sensors installed in that runway to give them an appreciation of any water forming on the surface.

Q Do you know if that data is provided to the tower or -- or to the ground operations?

A Normally, the units that I've seen at other airports, it's provided directly to the tower in a CRT display, and some runways have as many as six or eight of these sensors on both sides of center line and at either end of the runway.

Q And do you believe some kind of automated system like that should be required for airports that have air carrier operations in to and out of them?

A Well, it would definitely help in their assessment of knowing what the runway conditions are at any point in time. If you've got to go out at night time and inspect the runway, there's only so much you can see, and these sensors would aid in night time operations.

Q Do you know if they have a history of maintenance problems or accuracy problems?

A My understanding is that they're quite reliable, and some units have been installed as long as 10 years. The one at JFK, I believe, is 10 years old.

Q Thank you. Based on your knowledge of the entire data set for this accident, do you think we had normal or abnormal antiskid operation, and could you show Page 19 from your exhibit during your answer?

A Right. Well, one of the big drivers for antiskid operation is having the weight on the main gear tires, and with the fact that the DFDR data indicates the spoilers were not deployed, this factor of weight was not available to improve the braking force or the cornering force on the tires, and hence I would expect abnormal antiskid operation.

Of course, as we all know, the pilots did select manual braking, and my understanding of the antiskid operation on the MD-82, even if they had selected auto braking, the fact that the spoilers didn't deploy, they wouldn't have auto braking available to them.

Q Do you think we got good wheel spin-up?

A Yes, I do, based on the vertical velocity that's measured on the DFDR, and the fact that he was near center line on the downwind side, and the wind would have an effect on minimizing the water depth in that area.

Q The data do show that we got brake application after touch down. So, therefore, those two things in mind, would you expect normal antiskid operation in this case?

A Well, again, the antiskid itself would act normally, but the braking force developed would be considerably less than what I would expect because of the fact of not having the spoilers deployed.

Q Okay. Thank you. So, in summary, during your on-scene and subsequent investigation of this accident, have you found any evidence of dynamic hydroplaning, viscous hydroplaning, or reverted rubber skidding, and in answering this, would you please explain how you came to your conclusions for each phenomena?

A Yes. I guess the best way would be to go back to Figure 8, I think, in the exhibit that depicts the three types of wet pavement friction losses, viscous, dynamic and reverted rubber skidding.

First of all, starting with viscous rubber, viscous hydroplaning, we had good micro texture. We had grooving, and we had better than average tread groove depth remaining on the four main gear tires, and on that basis, I found no evidence of viscous hydroplaning occurring on the runway.

The fact that we had these scrub marks on the pavement eliminates dynamic hydroplaning. Under dynamic hydroplaning, your tires are basically behaving like a water ski. They've lost contact with the pavement surface. They're riding on a film of water, and you can't develop any braking or cornering capability.

The fact that we had these scrub marks on the surface, the pilot was able to bring the airplane from a severe right drift back across the runway and then rotated it again, indicates to me that dynamic hydroplaning was not a factor in this accident.

In terms of reverted rubber skidding, good pavement texture, the grooving, helped eliminate that as a probable cause in this -- in the performance of the tires on the pavement at -- on Runway 4 Right.

We found no evidence of tread rubber reversion on the surface, which, in earlier accidents, I have found granulars of rubber on the surface that were reverted, and we found no evidence of tread reversion on the -- on the four main gear tires. This would be reflected in a flat spot on the tire with molten rubber around the periphery. This was not in evidence on the four main gear tires of the MD-82.

So, in that respect, these three types of losses on wet pavement were not present, but by no means do I want to indicate that the water on the runway had no influence on the braking and steering capability of the tires. It definitely degraded that capability, and -- but there were other factors that entered into the decreased stopping performance of the airplane, including, of course, not having the spoilers deployed.

Q Could we put up Slide Number 11 from your exhibit again, please? For both aircraft, this slide shows that the wet grooved friction is essentially identical to the dry friction obtained.

Would not having the spoilers deployed affect where the wet grooved friction effect of friction curves --

A Yes, it would. In both of these instances, the spoilers -- the spoilers were deployed prior to brake application. We have tracked data that -- that indicates the -- the effect of -- of lift on the ability of the tire to develop effective friction coefficient values, and -- and I believe we've got it for the tire sizes that's on the MD-82, but I'm not sure.

I could look at that when I got back to Langley next week.

Q Okay. In general, would it have the tendency to reduce the wet friction shown there?

A Yes, it would. Just how much, I hesitate to say right now.

Q Okay.

A These tires were at a different pressure, of course, than the MD-82, and that would have an influence on it.

Q Okay. Again based on your knowledge of all the data that you're aware of for this accident, how did the flight crews control techniques, control inputs, or lack of control inputs affect the braking performance of this airplane?

A Well, first of all, I want to make sure everybody understands I'm not a pilot, and what they did during this event is -- is hard for me to say yea or nay on, but I -- I am impressed by the fact that they were able to recover from this right drift that occurred shortly after touch down, and to my way of thinking, that further substantiates the fact that they were developing some forces between the tire and the pavement, and the scrub marks substantiate that.

The -- not having the spoilers deployed was, I think, a key element in not realizing the normal stopping distance that they would expect to get, and then the delay in applying full braking may have compromised their stopping capability.

I hesitateto say how much, but I think the manufacturer would have more data in this respect.

Q Okay. Thank you. Have you done any energy calculations to try to estimate how much of the kinetic energy was reduced on the runway during its travel down the runway?

A Yes, I have. Just simply based on one-half of the mass times the velocity squared, when you consider it touched down at a 150 knots and left the runway at 90 knots, and you work out the numbers, that's about 56 percent of the total energy it took for the airplane to come to a stop at the end of the embankment.

So, he was developing somewhat greater stopping forces than one at first realizes, and possibly another 500 feet of runway, he might have been able to stop him.

Q Okay. Thank you. Another question. Could there have been partial tire contact patch detachment and still leave the marks that we had?

A There could be, but again the marks, the width of them, and the way they varied as the -- as we know the plane yawed going down the runway does not indicate that -- well, I would have to say less than half of the footprint was supported by any type of water.

It would be in the neighborhood of 20 percent at the most, based on the width of the scrub mark versus the normal width of the tire footprint area.

Q Okay. And would there have been any tire mark or other runway evidence of viscous hydroplaning?

A No, there would not.

Q Thank you, Mr. Yager. That concludes my questions.

CHAIRMAN HALL: Very well. We will move to the tables. I think it's American Airlines to start this out. In fact, am I correct on that? Ron, you went first last time, didn't you, or --

MR. HINDERBERGER: I frankly don't remember.

CHAIRMAN HALL: You were sort of scowling. I just was concerned that I had overlooked you. No? Okay. Well, American Airlines?

MR. BAKER: Thank you, Mr. Chairman.

INTERVIEW BY PARTIES TO THE HEARING

BY MR. BAKER:

Q Good morning, Mr. Yager. Can you kind of draw all this together from a layman's point of view, and give us your view on what you attribute the minimal traction experienced by Flight 1420 as it traveled down the runway? Can you kind of paint that picture from beginning to end of the factors?

A Okay. From the point of touch down, I think the friction level was good. The tires should have spun up due to the fact that he was near the center line. He was on the up wind side of the runway, and the sink speed at touch down was fairly high, which is a recommended pilot procedure for wet runway operations.

The tire marks started shortly thereafter and went off to the right side of the runway where he was able to bring the airplane around and start going back across the center line.

At that portion, he had not applied any substantial wheel braking, and all the forces developed between the tire and the pavement were going into his steering requirements, and, of course, at those speeds of above a hundred knots, he was getting some steering, of course, from the aerodynamic forces, the rudder and the -- in particular.

And then once he starts going from the right side of the runway to the left side of the runway, he's getting more thrust reverser. He's started applying full braking, although my recollection of the DFDR, that took about six seconds from the time the brake pedals started moving till the time he got to full pressure, and, of course, at 200-250 feet per second, that eats up a lot of runway.

And nominally in terms of friction coefficients, in that area where he goes from the right side of the runway to the left side of the runway, I would expect in the neighborhood of between .1 and .15 friction coefficient for -- for braking.

He's in the center line portion, and that would be the least amount of water, and then, of course, when he gets off on the left, there is more water present on that side based on the wind direction, speed and the fact that the last 13 lateral feet of the runway are not grooved, it's a lower texture, you would suspect that he would get into a hydroplaning situation there.

The marks, however, indicate that the tires still were maintaining some contact with the pavement, even on that non-grooved portion, just prior to going into the grass, and the longitudinal acceleration trace does not reflect any rapid decrease or any change in braking effort.

I don't know if that completely answered your question or not, but --

Q Yes. Yes, it does. Thank you. The friction on the runway, the steerability of -- of the tires, and aerodynamics all play into the control of the direction of the airplane.

Would you agree from your analysis that pilot control and input probably accounted for the initial skid recovery as opposed to steerability of the -- of the tires themselves?

A Right now, I've got to say it was a combination due to the fact that we had the scrub marks in the area where he brought the airplane back around to the center line.

Q Have you calculated how fast this airplane would have been going had it -- had the runway been flooded, and it had rolled 5,200 feet without spoilers?

A No, I havenot.

Q Are you aware or -- or have you considered actually doing this operation in a simulator to verify your thoughts?

A No, I have not considered that possibility. Right now, we do not have a sim at Langley that would replicate the MD-82 configuration.

Q Have you ever used flight simulators to replicate these kinds of events, and are they useful in your work?

A They are. They are quite useful, and like I say, I spent several weeks in Long Beach in the '70s developing one on -- on the DC-

9, and they can be quite useful.

Q Was there any testing done on this particular runway to depict what would have been a flooded runway condition?

A We in our drainage test in November were basically trying to identify if there were any areas on the runway that would produce flooding, and admittedly, we didn't test every foot of the runway, but we did it in 500-foot increments, and in no case was there a ponding problem on that runway that would create a flooded condition.

Q So, that's a -- but that's a drainage test, not a test of the effects of flooding on this runway, including the crosswind?

A That's true, and in order to do that, we'd almost have to rely on Mother Nature. A tanker truck wouldn't -- wouldn't be able to supply water fast enough to flood that runway.

Q Has that work ever been done in -- in other events?

A Yes, it has. I was involved in a T-38 accident at Ellington Air Force Base in the late '70s, where a T-38 with one of our shuttle astronauts on it landed, and it was right at the runway intersection, and there was as much as an inch and a half of water there that we found during subsequent tests with a tanker truck, and his tires never spun up on touch down, and he went off the side of the runway and ended up on a taxiway.

Q Would you -- would you characterize that as hydroplaning or what was your conclusion?

A Well, the conclusion there was that where he touched down, he got into dynamic hydroplaning, no wheel spin up. He applied no brakes whatsoever during the entire roll-out. When he came out of the pond, his tires did not spin up again. They stayed in a non-rotated condition and reverted rubber developed, and we got very distinctive white marks on the pavement that were much -- much more distinctive than the marks that I saw out on Runway 4 Right, and these persisted all the way to the edge of the runway, and then the plane went through about 400 feet of grass and mud and stopped on the taxiway, and both main gear tires still had tread rubber reversion in the skid patch on that particular airplane.

Q That -- that pattern of white marks, were they uniform all the way down the runway?

A The pattern from the T-38 was, with the exception of the last hundred feet, where he started yawing left, and they became a little bit wider in that area. The width of them became wider.

Q Would you describe the pattern you observed on 4 Right left by 1420 to be uniform all the way down?

A No, I would not. They varied in concert with the -- the aircraft yaw angle. They started out being one width, and as they approached the right side, they became somewhat wider.

Q Have you seen the -- observed the tires on the airplane since the accident?

A Well, a couple of days after the accident is when I observed them.

Q And I think you -- you indicated earlier that you saw no reverted rubber on -- on those tires, is that correct?

A That's correct.

Q Have you -- have you ever been involved in an event in which the reverted rubber was removed as a byproduct of going through the mud and terrain as this airplane did? Is that possible in your view?

A It's possible, but like I say, I've observed this T-38 accident where it didn't happen.

Q Are -- are there any other tests that you're familiar with or you could recommend that these tires could be put through to ascertain if -- if in fact there had been rubber reversion, other than simply a physical observation of -- of the tires?

A Not at this time, I do not know of any laboratory tests.

Q You showed us a chart of stopping distances based on some work done with a Conveyor 880 which, if my memory serves me right, is an airplane of the vintage of the early '60s.

Have newer charts been developed representing today's aircraft, such as the Super 80?

A We do not have one for the Super 80, but we've got one for the 757.

Q Do -- do they match up pretty well, if you take all the dynamics involved with the 880 material?

A Actually, you get better friction coefficient and better braking compared to the 880.

Q In your opinion, were the wheels turning as the aircraft went through the grass after it exited the left side?

A Yes. We've done tests, just as a footnote, on several different soil surfaces in support of Army and Air Force operations, and we found that once the tires lock up or are stopped rotating on a non-rigid surface, they tend to bury themselves, and the landing gear would -- would shear off, and that's one reason why I think they were -- they were rotating.

Q You indicated that parts of this runway would reasonably considered -- be considered to have been flooded. If it has a water depth of 0.10 inches, what rainfall rate would it have taken, given the -- the runway friction surface and drainage and all the rest, for 4 Right to be considered to have been flooded?

A Two inches per hour. This is at an area 15 feet from the center line.

Q Even with a well-constructed runway that has good grooving and crowning, is it possible for there to be a rainfall rate or an accumulation so great that the design of the runway could not evacuate the water leading to ponding, pooling, or standing water on the runway?

A There -- there could be that situation, if the surrounding terrain, the non-paved portion outside the runway shoulders, was such that it acted as a dam. It did not have the cross fall that the runway itself had, and then the other factor would be the wind. If it was a no-wind condition, that -- that would contribute to an accumulation of water.

Q Do you believe that the crosswind conditions that you heard in the testimony the last two days may have contributed to the flooding on this runway? How would you describe that?

A Well, the -- the crosswind that was present from the pilot's position left to right would mean that on the left side of center line, the water would be what I termed "stacking". It would be accumulating because the wind effect would be to slow down the drainage of any water that exceeded the -- the groove depth and the texture depth, whereas on the downwind side or the right side of center line, it would increase the drainage capability and literally blow the water off the surface.

Q Now, on either side of the hard surface of this runway, it's -- it's grassed, as -- as we all know. Do you have an opinion as to -- or -- and did you do any work to ascertain the effect on the drainage of this runway having to do with the height of the grass on the day of the accident or the nature of the soil on either side of the runway? Did you -- did you look at that aspect of this at all?

A We did in November, when we did the drainage test, and as you know, there's no way of telling with certainty how the soil/grass terrain was comparable to what was present in June.

Admittedly, in November, the grass height was greater than the pavement height, and once the water reached the edge of the pavement, it started disappearing into the grass, and you could see it trickling outward. There was still a gradient there, but the -- the rate that the water went out from the edge of the runway was definitely slower than what was on the paved runway, but part of that is due to absorption by the soil.

Now, I did not take any soil samples to determine the moisture content and that type of thing, but I was mainly interested in the paved surface when did those drainage tests.

Q So, if I could summarize, you didn't do any specific assessment of the drainage capability of -- of the soil structure, and -- and you believe that the height of the grass can have an effect on the damming and the drainage characteristics of a runway?

A Yeah. Just visually, I have observed the water slowing down, yeah.

Q Thank you very much.

CHAIRMAN HALL: Allied Pilots Association?

MR. ZWINGLE: Thank you.

BY MR. ZWINGLE:

Q Mr. Yager, with reference to the T-38 accident at Ellington Air Force Base that you mentioned previously, the marks left on the runway by the tires traveling down the runway, were they uniform in color throughout?

A Yeah. From the time he left the ponded area till the time he exited the right side of the runway pavement, they were uniform in color.

Q Okay. But they were not uniform in dimension, correct?

A That's correct.

Q In order to leave these distinctive marks on the runway, is it necessary to have water between the tire and the runway?

A Yes, it is.

Q Okay. With regard to Exhibit 13A, Page 5, -- do you have that, sir?

A Yes. Yes, I do.

Q Okay. The date of the exhibit I have, I believe, is the 20 --

I'm sorry -- the 6th of January '99. Is that the one you have?

A No, it isn't.

MR. CLARK: 2000.

MR. ZWINGLE: Does it say '99?

MR. CLARK: I think it does.

MR. ZWINGLE: Now I know where the Y2K problem lies.

THE WITNESS: Okay. I've got it.

BY MR. ZWINGLE:

Q The second paragraph from the top states, mid-paragraph, that "the runway's capable of handling rates up to 1.4 inches per hour", and I believe you stated that in your belief, the runway's capable of handling up to two inches an hour, is that correct?

A That's correct, based on the combination of both cross fall and macro texture.

Q From the testimony that was given yesterday by your meteorology experts, do you recall the definition of the Level 5, Level 6 NWS VIP scale thunderstorm?

A Not specifically, but I understand that's a severe rain storm.

Q Okay. Do you recall that the Level 5 thunderstorm is defined as capable of producing rainfall intensity of over 2. -- up to 2.5 inches per hour?

A Yes, I do.

Q Do you recall that the NWS VIP Level 6 thunderstorm is capable of producing rainfall up to 5.5 inches per hour?

A No. I thought it was even higher than that. 7.2, I thought.

Q I'll take it.
A Anyhow, --
Q Based on that, --
A -- I was --
Q Based on that rate of rainfall, could this runway have been flooded?
A Oh, yeah.
Q Given that the thunderstorm existed?
A Right, and there was no wind.
Q Okay. With regards to the crosswind that existed, does not your statement that the left side of the runway would be flooded and the right side of the runway would not be flooded, does that assume that the water on the left side of the runway cannot transgress the center line?
A No, that doesn't assume that.
Q Okay. Then with the velocity --
A But --
Q -- of the winds -- with the velocity of the left crosswind, cannot water on the left side of the runway transgress to the -- the center line and augment the precipitation already falling and accumulating on the right side of that runway?
A It could, if conditions were severe enough, and right now, I do not consider that the conditions that severe. I consider the fact that with the crosswind, the flooding on the left side would have gone up to about 15 feet from center line. It would not have exceeded the center line, and on the downwind side or the right side of the runway, that water

would have been expedited off the side.

Q And what value of wind velocity would you use in that assumption?

A This would be a value of 20 knots. That would accommodate stacking the water depth that was greater than the macro texture, and the macro texture of the -- of the surface, at least in the middle portion of the runway, was like .05.

Q Why would you use the value 20 knots in that assumption?

A Based on experimental data that we've collected at other runway sites, where winds have been present, and under similar cross fall conditions.

Q Now wait a minute. The crosswind conditions during the period of precipitation prior to the accident, when precipitation began, which was approximately, I believe, 15 minutes prior, did we not have or do you recall evidence that crosswinds in excess of 20 knots existed?

A Yes.

Q Did you conduct friction tests in the non-grooved portion of the runway?

A No, we did not.

Q Your -- your term -- the term you used "scrub", is that defined anywhere? Do you have a definition for that term?

A It means a change in the coloration of the pavement in the surrounding area, the area outside of the scrub mark.

Q Okay. And can you account for that change?

A Due to the tire footprint pressure acting on the wet pavement.

Q Solely pressure? No friction?

A Well, pressure produces friction, and friction results in the scrubbing action, and that friction can be both cornering and braking -- and/or braking.

Q Can you state conclusively that the accident aircraft did not -- I'm sorry. Let me restate that.

Can you state conclusively that the accident aircraft experienced wheel spin-up?

A I guess it's a matter of interpreting the term "conclusively". Based on prior knowledge of how aircraft tires behave, under wet pavement conditions, I would say they would have spun up.

Q But you've referenced DFDR data with regard to the spoilers. Do we have conclusive evidence from your examination of the DFDR that there was wheel spin-up?

A Well, one parameter that I look up -- look at in terms of wheel spin-up is the vertical acceleration at touch down, and if it's above one g, I consider that a firm to hard touch down, and that helps in allowing the tire to penetrate whatever water depth there might be in that area and rapidly spin up within a second to at least the threshold velocity where the antiskid would start operating.

Q And that would be even including momentary contact?

A Yeah. Momentary being in the -- in the neighborhood of a half a second.

Q Do you agree that the marks left on the runway for at least one of the main landing gear, and I believe it's the left main landing gear, and the nose gear was not continuous with that of the right main landing gear?

A Yeah. There were some gaps.

Q There were some gaps?

A Yeah. We've got, of course, a chart of those wheel tracks, if you want to look at it.

Q Yes, I'm famliar with them. I asked that question for clarification.

The question was asked by American Airlines regarding the possibility of -- of evidence being removed from the tire due to its travel through the non-runway surfaces.

Did you sift the soil between the end of the runway and the point where the aircraft stopped? Was there any soil sifting?

A There was no soil sifting.

Q In your opinion, do the main landing gear tire marks indicate that braking appeared -- braking occurred?

A It's hard to distiguish in just looking at the scrub marks where they're -- how much is attributed to braking and how much is attributed to cornering. It's a combination thereof.

Q If the antiskid system were in operation and was cycling, and do you understand what I mean by cycling, would you expect the appearance of the tire marks to change as the antiskid cycled on and off as pressure --

A Yeah. If the -- if the airplane was in a non-yaw position or non-yaw attitude, I would expect the marks to change.

Q Did you notice a change in the appearance of the marks?

A Well, I noticed a change, but it wasn't in the area where there was any braking, wheel braking.

Q Could evidence of reverted rubber have been washed away by the heavy rainfall and wind?

A Yes, it could have.

Q My last question. Can you offer an explanation as to why American 1420 exhibited a deceleration rate of only 10 knots per thousand feet?

A Basically, it was due to the amount of energy required for directional control that compromised his deceleration level, and the fact that the spoilers were not deployed. So, then -- when he did get into a braking -- a tire-braking mode, the braking force was not as high as what it should have been with the full load on the main gear tires, and those are the two main reasons.

MR. ZWINGLE: Excuse me, Mr. Chairman. I have to retract the preface that this will be my last question in response to -- to this response.

BY MR. ZWINGLE:

Q Do you know conclusively that the spoilers did not deploy on landing? This is not to say that the spoilers were found in the retracted position.

A All the evidence that I've seen that has been collected relative to the accident indicates the spoilers were not deployed.

Q And that evidence is?
A Basically the DFDR and the -- well, basically the DFDR.
Q And -- and do you know the sensing parameters of the DFDR with regard to the spoiler system?
A Well, I've got -- I've looked at a copy of the DFDR tracings.
Q But do you know -- are you aware of the sensing parameters? How many spoiler panels are sensed --
A Oh, okay.
Q -- in sensing --
A Yeah. Right. Two. Two are sensed.
Q Have you conducted any study on the -- on other similar air carrier accidents with regards to wet runway overruns or --
A Yes, I have.
Q -- contaminated runway overruns?
A Yes, I have.
Q Can you tell me which ones you're familiar with?
A There was one involving a Portuguese airliner, a 727, in Fucho, Madera. Looked at a DC-9 accident at Baton Rouge, Louisiana. Well, the one in Baton Rouge, Louisiana, went off the side of the runway, not the end of the runway. Looked at a 737 aircraft that went off the end of the runway at LaGuardia. There's -- there's been a number of them. I'd have to --
Q Korean Air -- Korean Air MD-80 in Korea?
A I did not look at that accident.
Q Have you been able to draw any similarities since the

occurrence of this accident and -- and previous accidents you've looked at?

A Well, the one involving the DC-9 at Baton Rouge was reverted rubber skidding. There was evidence on the tires. The 737 at LaGuardia, we had the scrub marks, but we didn't have tread reversion nor viscous nor dynamic hydroplaning.

Yeah. Basically, when I came to support the NTSB investigation team in June on this accident, I -- I did do some comparisons with my experience with other accidents.

Q No further questions.

CHAIRMAN HALL: The Association of Professional Flight Attendants?

BY MS. LORD-JONES:

Q On airplanes with no wheel spin-up, which are not locked, will braking systems work to his knowledge -- to your knowledge?

A They will not work effectively because they don't have a speed reference to go by. They need a wheel speed reference to develop the necessary brake pressure to develop braking forces.

Q Thank you.

CHAIRMAN HALL: National Weather Service?

MR. KUESSNER: No questions, sir.

CHAIRMAN HALL: Little Rock National Airport? Maybe the Little Rock Airport -- Mr. Yager mentioned sensors in your concrete out there, your --

MS. SCHWARTZ: Yes, sir.

CHAIRMAN HALL: -- pavement, and he didn't know where they are read out. Where -- where are they read out?

MS. SCHWARTZ: Sir, I don't have the answer to that at the present time, but I can obtain the information.

CHAIRMAN HALL: If you could, and let us know, we'd appreciate that, Deborah. Thank you.

MS. SCHWARTZ: Very good.

CHAIRMAN HALL: Go ahead.

BY MS. SCHWARTZ:

Q Mr. Yager, if more brakes had been applied earlier and spoilers had been deployed, are you able to tell us whether you believe the aircraft would have stopped safely on the runway?

A My cursory calculations indicate that it would not have been able to stop on the runway due to its touch down position and having only 5,200 feet remaining. I think a later presentation this morning will get into more details on that.

Q Thank you. Under your definition ranging from wet to flooding identified in an earlier overhead, how would you characterize the runway condition at the time 1420 touched down?

A It varied from wet on the right side of center line to a flooded condition on the left side.

Q To clarify, do you believe there was any -- you have just referenced wet to flooding. My question, which was posed before -- which I had prepared before you answered, to clarify, do you believe there was any flooding on the runway during the landing of 1420 or could you elaborate?

A Well, based on the available weather information that has been discussed yesterday, I would suspect there would be flooding on the runway. It would be primarily on the left side, and it would be primarily in the area that didn't have the grooving, and due to the crosswinds, the -- the area to the right of center line would be under a wet condition.

Q Continuing in response to that, if you're characterizing the flooding as primarily being in the non-grooved portion of the runway surface, would you say then that there was any flooding in the grooved portion of the runway surface?

A Yes. Knowing the -- the time frame of the -- of the rain shower event, I would suspect that the flooding had gotten up to within probably 15 feet of the center line prior to Flight 1420 touching down.

Q Prior to, but at the time of landing, sir?

A At the time of landing, up to within 15 feet of the center line.

Q Do you believe there was any ponding on the runway during the landing?

A Based on the transverse gradient measurements that I took in June, and then the later drainage measurements in November, I found no evidence of areas that would produce flooding.

In other words, there were no low spots in the runway that would -- would pond.

Q Okay. Again for clarification, you just said that there would be no areas that would produce flooding. In an earlier response, you said there was flooding. Were you using flooding and ponding interchangeably in your last response?

A Okay. I -- I can see the dilemma here. In the drainage tests, we were applying water on center line and measuring how long it took that water to go from center line to the shoulder, and in each case, in 500-foot increments down the runway, that time element remained fairly constant at between .77 and .75 feet per second.

Admittedly, under a rain shower event, the entire runway is getting wet, and as the rain shower continues, and it changes in intensity, the -- the water depth on the runway is going to start to increase at the edge and then move towards the center line which is the high point on the runway, and under those situations of a natural rainfall event, you could expect water depths exceeding a tenth of an inch on that left shoulder area.

Q Can you tell me if your flooding conclusion is based on the actual rain event or based on your test results?

A It's based on test results, and the chart that I showed in my presentation, which uses transverse slope and average texture depth as the two parameters in determining the rainfall rate necessary to flood to within 15 feet of the center line.

Q Did the water between the runway and the tire which caused the scrub marks cause hydroplaning?

A No, it did not.

Q Thank you very much.

CHAIRMAN HALL: I don't guess those sensors have recorders on them, do they?

THE WITNESS: Some of them do, the newer ones.

CHAIRMAN HALL: Did we get that?

THE WITNESS: Whether or not --

CHAIRMAN HALL: Look into that, Mr. Feith, and find out whether the sensors at the airport have a recorder capability?

All right. The Little Rock Fire Department?

MR. CANTRELL: No questions, sir. Thank you.

CHAIRMAN HALL: All right. Federal Aviation Administration?

BY MR. STREETER:

Q Mr. Yager, I've got two values down here. I probably missed something, but I -- I heard you say that the runway configuration as you examined it out there on 4 Right would accommodate either 1.6 inches or two inches of rain per hour. Which -- which was correct there, sir?

A Oh, okay. The 1.6 inch value was based on the two inch spacing, quarter inch width and three-sixteenths depth of the grooves on Runway 4 Right.

If you take into account what the current AC recommends of one and a half inch spacing, quarter inch deep, quarter inch width, it would bring that required rainfall rate up to two inches.

Q Okay. So, -- so, the actual configuration that existed on the runway at the time, the 1.6 inches, is what you would expect it to accommodate?

A Right.

MR. CLARK: Let me clarify that. If that's coming out of the

13A, Page 5, it's 1.4.

MR. STREETER: All right.

BY MR. STREETER:

Q And that's fine because the key point here is not so much the value as I'm trying to determine when you say it can accommodate that, what do you mean by accommodating? Does that mean that that -- if we exceeded that level of rain, it would move into what you're defining as a flood condition?

A Right. The other factor that goes into the equation to determine what rainfall rate produces flooding is what is the path length from the center line that you're interested in determining where flooding occurs.

Now, that particular chart was set up to indicate flooding in an area 15 feet off the center line. Now, if you went to 30 feet off the center line or 60 feet off the center line, you would get a different rainfall rate. It hinges on the drainage path length.

Q Well, just so I'm aimed in the right direction, if you did go 30 feet off the center line, would it be a greater or lesser rainfall rate to flood the runway?

A Lesser rainfall rate.

Q A lesser rainfall rate.

A Right.

Q Okay. So, for your -- for the purposes of -- of what you're observing that night, then your judgment that this was a wet runway -- and let me make sure I have that definition right.

For your purposes, the wet runway was less than a tenth of an inch of water on the runway, is that correct?

A Less than .01.

Q .01.

A .01 to a tenth of an inch.

Q Okay.

A Excuse me.

Q All right.

A You're right.

Q Okay. .01 to a tenth.

A Right.

Q So, -- and -- and your -- in your judgment that night at the -- at the position you believe that the pilot would have been at, laterally on the runway, it was -- it would have been a wet runway?

A That's -- that's correct.

Q Okay. Now, I believe you stated earlier on a question there with the Little Rock Airport, that this was based on calculations.

A That's correct, and right now, they're considered conservative.

Q Okay. And that -- and the -- and one of the elements in that calculation was the rainfall rate, and that rainfall rate, I presume, came from the other data that's available? I mean official rainfall rates?

A Oh, yeah, and they were -- they were taken from gauges that were located near where we were doing the measurements of the water depth, texture and cross fall.

Q Okay.

A Yeah.

Q All right. Now, at -- at a tenth of an inch then, that's where we're going to shift from your definition of wet runway to flooded runway, and don't let me put words in your mouth. I'm trying to say this to make sure I -- I -- I thought I heard you state earlier that under the conditions that you described, that you had no doubt that there was wheel spin-up on those conditions.

If the water depth was slightly greater, enough to move it into the flood stage, would you have the same level of certainty on the wheel spin-up?

A No, I would not.

Q I believe that -- and this is again where I missed part of the question, but there was a question from Mr. Clark to you regarding the marks, and the answer was that those were marks you would expect to see on a dry runway.

I missed that. Was that referring to the scrub marks you observed or the black skid marks?

A They were referring to the black skid marks.

Q Okay. So, the black skid marks, you -- is -- that's a dry runway trait?

A Right.

Q And the scrubbing condition that you described then would be a runway with some degradation due to water or -- or contamination?

A Yes.

Q Okay. Thank you very much, sir. That's all I have.

CHAIRMAN HALL: Very well. This witness has got the party tables interested obviously. Boeing Commercial Airplane Group?

BY MR. HINDERBERGER:

Q One question, Mr. Yager. In your experience, if a -- if a tire on an airplane experiences reverted rubber condition, is there evidence left of that on the tire?

A Yes, there is.

Q Okay. And were there -- was that condition -- did you see that condition on the -- on these tires of the accident airplane?

A No, I did not.

Q Thank you.

MR. BAKER: Mr. Chairman, I have two quick follow-ups, please.

CHAIRMAN HALL: Yes, sir.

BY MR. BAKER:

Q Mr. Yager, did you get involved or are you familiar with the UPS event in Houston of last year with the freighter?

A Yes. That was at Ellington Air Force Base -- Ellington Field, I believe.

Q That's correct.

A With a DC-10, yes.

Q 75 or 76. I'm not sure which.

A Excuse me. It was a 76, right.

Q So, you studied that particular event?

A Right. In fact, they sent all 10 main gear tires to our facility at Langley.

Q Are your findings and opinions of that a matter of public record anywhere?

A Yes, they are. We -- we gave a report to the -- to the NTSB investigator supporting that -- that accident, we being myself and another engineer in the office.

Q Without going into it very far, would you suggest that what you saw there in any way to be similar to what happened to 1420?

A It was similar in the fact that in both cases, it was a wet runway. The main difference between Ellington Field and Little Rock is that Ellington Field does not have a grooved runway, and hence the -- the ability to support dynamic hydroplaning was greater at -- in the 767 accident than in the case here at Little Rock.

Q So, you concluded there was dynamic hydroplaning there?

A Yeah.

Q You heard earlier testimony that there's an impression among some of us that follow aviation closely that this whole issue of overruns on wet runways is a bigger problem and growing.

Are you aware of anyone trying to do an overall assessment or correlation of these events to see if there are systemic problems we ought to deal with, and are you involved in any of those kinds of efforts?

A Right now, I'm mainly involved in documenting any overruns or veer-off accidents that occur under snow and ice conditions, and I know since November through today, there's been at least six mishaps of a variety of airplanes that have gone off the side or the end where there's been no injuries, no damage to the airplane, it's just towed back out and brought back into service, and --

CHAIRMAN HALL: We've made seven, Mr. Yager. We just had one at Newark.

THE WITNESS: Oh, okay. And it's these type of statistics that sort of get swept under the runway, and it should be tabulated and should be critiqued as to why it happened, and what -- what were the factors involved, and how can we prevent it in the future?

Admittedly, I realize the manpower limits of the NTSB and the aviation community to do this, but, yes, I think there would be value in tracking these mishaps and these incidents.

BY MR. BAKER:

Q One last question. Back to Ellington for a minute. Were there marks on the runway, and how would you describe or compare them to the marks you saw on 1420 which you described as scrubbing?

A Right. The marks on the runway at Ellington were not significant and were not what I'd classify as scrubbing.

Q So, they were not similar to this, and I think I heard you say earlier in your testimony that typically with dynamic, there are limited or no marks?

A That's correct.

Q Thank you, sir.

CHAIRMAN HALL: I believe that Mr. Pereira wants to take the floor again.

INTERVIEW BY TECHNICAL PANEL

BY MR. PEREIRA:

Q Mr. Yager, could you put up the slide that shows the rainfall rate and the micro texture values that's centered a lot of the discussion we've been having the last half hour? I believe it's Slide 16.

A Right. Slide 16.

Q When we say that this is an indication of flooded conditions if you get above these curves, what depth, what water depth is that?

A A tenth of an inch.

Q Okay. And what -- where would these curves go if we wanted the depth to be at two-tenths or a quarter of an inch? Would they shift up or down?

A They would -- they would shift up.

Q And what water depth, given the tread depths of the accident airplane tires, would be required to sustain dynamic hydroplaning?

A Since the minimum average tread depth was two-tenths of an inch, that would be the value.

Q So, in terms of context, would these curves be more appropriate for this accident if they were adjusted to a flooding depth that would cause hydroplaning for this accident airplane?

A That's correct. That would be one factor that would raise them and would require a higher rainfall rate.

Q Okay. So, then would it be -- do you have any idea how much more than two inches per hour it would be required for our cross slip and our tire depth?

A Not immediately, but I can do the calculations and come up with those values for you later on today.

Q Okay. And even if we did have a tenth of an inch on the left-hand side of the runway due to the crosswinds and the rainfall rate, do the marks and the tire tread depths indicate that it supported dynamic hydroplaning in the case of this accident?

A No, they do not.

Q Okay. Earlier, I think there was a question that I was confused on. I believe somebody asked would the rain have washed away the evidence of reverted rubber, and I thought I heard you say yes. Is that true for the tires? Would the heavy rain that occurred and hail have washed away the evidence of reverted rubber on the tires?

A No, it would not. What I was referring to was evidence on the runway. In some situations, I have found granulars of rubber that had been reverted, that were a residue on the runway itself, and in this instance, I did not find any of that evidence.

Q Okay. And I also thought I heard the airport ask you did you think if this airplane had had brake actuation at an early stage, let's say, consistent with auto brakes or early manual application, and full spoiler use at an early stage, consistent with auto spoilers, do you think it would have stopped on the runway with the wet conditions that we had?

A No. Under the conditions -- I understood the question from the airport as being similar but still not having the spoilers deployed.

With the spoilers deployed, you are going to get more weight on the wheels and be able to create a higher braking force, but -- well, by the -- okay, okay.

Q Would you rather leave that up to Boeing?

A Yeah. I think I would.

Q Okay.

A Because what enters in here is the fact that if he didn't have the directional control requirements, then -- then most of the forces could go into braking.

Q Okay.

CHAIRMAN HALL: Very well. Thank you.

MR. PEREIRA: I had one more, Jim. Sorry about that.

CHAIRMAN HALL: All right.

BY MR. PEREIRA:

Q Lastly, we're talking about flooding on the side of the runway and crosswinds causing it to pile up. It just struck my curiosity that a lot of developments and highway roads seem to have flood control devices, essentially drains, on the side of roads that help take away some of that standing water.

Do any runways in the U.S. or around the world have that, and do you think they should?

A Oh, yes. There's several runways that have drainage channels outside the edge of the runway to further accommodate drainage. That's more prevalent in England than anywhere else, I guess because of the -- the frequency of rain events over there, but, yeah, that could -- that could help.

Q Okay. But it's not a requirement in the advisory circular or anything right now?

A No. There are guidelines in the advisory circular relative to water drainage, but not to the extent of culverts or drain -- drains.

Q What's your opinion on that, and do you think there should be or would it help?

A Well, it would help the drainage, but, of course, you don't want to have an obstruction for the airplane of any consequence. It would have to be properly designed so that tires could roll over them without any impediment.

Q Okay. Thank you. That concludes my questions.

CHAIRMAN HALL: Who -- I assume there's somebody at the FAA that does this type of technology and work, and we're going to hear from him later?

MR. STREETER: We're going to try, sir.

CHAIRMAN HALL: Well, good, good. I'll get my engineers even more excited. Mr. Sweedler?

MR. SWEEDLER: Yes, Mr. Chairman, I just have one area I'd like to discuss with Mr. Yager.

INTERVIEW BY BOARD OF INQUIRY

BY MR. SWEEDLER:

Q Mr. Yager, you mentioned the far end of the runway was not grooved as was the other parts of the runway, and -- and you also noted that an extra 500 feet, the airplane might have been able to come to a stop on the runway.

But my -- my question is, the airplane touched down at -- at about, you said, 5,200 feet remaining. It's a 7,200 foot runway, and if the airplane had touched down earlier on the runway, where it might have been grooved, would that have made a difference in -- in the airplane being able to stop with all the other conditions being similar to what they were with the accident airplane?

A No, that still would not have allowed him to stop. I -- I misspoke when I indicated another 500 feet, and then, secondly, relative to the grooving location, I might have used the term at the far end, but what I meant was laterally.

The runway is transversely grooved the entire 7,200 feet, but on either edge, there's 13 feet that have not been grooved.

Q So, touching down a thousand or 1,500 foot earlier on the runway, in your opinion, would not have still made a difference in the airplane's ability to stop before it went off the end of the runway?

A Not if everything else stayed the same.

Q Okay. Thank you, Mr. Yager.

CHAIRMAN HALL: Mr. Berman?

MR. BERMAN: No questions, sir.

CHAIRMANHALL: Sure you don't have one? Mr. Haueter?

MR. HAUETER: I'll make up for Mr. Berman real quickly.

BY MR. HAUETER:

Q You made mention in terms of the wind effect on blowing the water off the runway on to the other side. If the wind had been much higher, say, instead of being 24 knots, it had been, say, 50 knots, would that increase or decrease the flooding effect?

A If the wind had been higher, there probably would have been a decrease in the flooding effect because basically it would provide more force to bring some of the water from the left side up over the center line and pushed off to the -- to the right side.

This is an interesting situation in that my data right now only goes to about 35 knots, but as the wind velocity increases, you get more -- a greater flow rate of the water that exceeds the macro texture depth, and it's possible that that force could offset what's needed to bring the water up over the center line, at least at a one percent slope, if not a one and a half percent slope, and hence it would help reduce the water depth throughout the width of the runway.

Q Thank you, sir.

A Okay.

CHAIRMAN HALL: Mr. Clark?

BY MR. CLARK:

Q You talked earlier extensively about scrub marks, and what would you -- if you had steam cleaning on the runway, I assume that's associated with the locked wheel hydroplaning?

A With the reverted rubber skidding, yeah.

Q What would that look like? What would be the differences between what you observed and what you would expect to observe if you had steam cleaning?

A It would be a much more distinct white mark as opposed to the lighter coloration that I observed on the runway at Little Rock.

Q Okay. If you exceeded the -- that .1 inch to get into the flooding category, and we touched down at this 149 knots, would that mean we automatically get hydroplaning?

A No, no, no. It does not mean that. Speed plays a role. Tire tread groove depth plays a role. Inflation pressure plays a role.

Q So, even with the -- something greater, if I were to get something greater than the .1 inch, that's still not a --

A A dynamic hydroplaning situation.

Q Yeah. Okay. You -- there was a term earlier called "ratcheting" in the brakes or locked wheel. What kind of evidence would you see if you had a tire or a brake system that was ratcheting?

A You would see irregular tire marks, particularly -- that occurs a lot on dry surfaces, and there would be a black mark with an interval of no mark and then another black mark, and it would persist down the runway.

Q Okay. If I -- when I landed in my -- if the wheels did not spin up, what would I expect to see?

A If the wheels did not spin up, you would see no mark on the runway surface. That would be basically supported by the water film between the tire and the pavement.

Q So, we would not have the mark or after a point in time, it would develop into the steam cleaning?

A Well, it would develop into the scrub marks that we have, and, yeah, if it remained in a non-rotating condition, it could very well develop into the steam cleaning.

Q Okay. But -- and then you just said that it would develop into the scrub marks we had. Does that mean the wheel would spin up and give us the scrub marks we had or the wheel would not spin up and give us the scrub marks we had?

A The wheel would spin up and give us the scrub marks that we had.

Q Okay. Is there any evidence from the marks that you see that the antiskid was not working?

A No. Based on the marks on the runway, I have no evidence that the antiskid was not working.

Q If the antiskid were not working, what would you expect to see?

A Similar marks that could be attributed to the steering requirements.

Q The cornering?

A Yeah. The cornering.

Q Okay. All right.

A It's hard to differentiate from the scrub marks on the runway, how much was attributed to cornering, how much is attributed to braking.

Q Okay. How many -- you've worked a number of accident investigations and have an extensive testing career. How many times have you seen evidence of this skidding, this type of skidding marks on a wet runway? How many times have you seen or observed on the runway evidence of hydroplaning that you can correlate back to specific data?

A Probably in the neighborhood of 15 to 20. Some of the accidents that I've supported have involved tire failures, such as the Continental DC-10 at LAX. We, being NASA, had a 990 airplane experience tire failure on take-off at March Air Force Base, but those were dry runways.

Q What about in the testing environment?

A In the testing environment at our track facility, yes, we can duplicate.

Q No. I'm asking how many times have you observed -- you -- you're giving us observations of what skidding looks like or hydroplaning or -- or locked wheel hydroplaning. How many times have you observed that and correlated that with data?

A Probably a couple hundred times with different size tires, different inflation pressures, going through speed ranges, looking at concrete versus asphalt surfaces, looking at grooved versus non-grooved, a variety of parameters.

Q Okay. That's all I have. Thank you.

A Thank you, John.

CHAIRMAN HALL: Mr. Yager, we appreciate your testimony. You have been with NASA how many years?

THE WITNESS: 37. I'm afraid to admit.

CHAIRMAN HALL: Well, that's outstanding service to the Federal Government and the people of this country. Thank you very much, and all of it in this specific area. I wish I had that type of concentration. I've wandered about in my career.

Well, as has been pointed out by Mr. Baker and obviously the Board is aware of the increased occurrences with runway overruns, and you mentioned, I guess, that we now have, with the event this morning in Newark, seven that have occurred already this year, --

THE WITNESS: Yeah.

CHAIRMAN HALL: -- we would certainly welcome any thoughts or final closing comments you would have as it pertains to this accident or this area and things the Board can -- should be considering as we continue our investigation and work.

THE WITNESS: Well, first of all, I think it's long overdue that -- that your staff, Mr. Hall, should be commended on the -- on the thoroughness of the investigation at each of the accidents that I've helped support, not only the thoroughness but the open-mindedness of the investigators to consider all possible causes, and with the main thrust being to improve aviation safety.

You're an organization that has some demanding requirements, and you seem to meet them to -- to the -- to a very good -- to a very high standard, and with that being said, from my viewpoint as a research engineer and one that's trying to also improve aviation safety, there are several areas that could be improved upon, and some of them were mentioned yesterday, and one of them being the runway reporting.

There's much better equipment out there now to give reasonable and comparable friction measurements that pilots can use in assessing runway slipperiness. There are sensors, and there are techniques recommended by the FAA, by the Joint Aviation Authority, by ICAO, to document runway conditions better.

The joint program that I'm involved in right now with Transport Canada and the FAA, we're trying to move forward in that area of runway classification, both in terms of condition and slipperiness, and we've achieved a certain degree of success in that we've taken measurements from 13 different vehicles and have been able to harmonize these measurements to all indicate the same value for the same runway condition, and so pilots will not be confused with a new meter reading at Heathrow versus a Saab friction tester reading at Dallas-Fort Worth. For the same conditions they would be reporting the same number.

We've got programs scheduled at Langley later this year to look at two other aspects. One, the algorithm for controlling the antiskid brake system. Up until recently, it's mainly been a matter of monitoring wheel velocity or wheel slip speed as the controlling device, and some of the newer airplanes have gone to a GPS system for a speed reference.

We're going tobe looking at a black box algorithm that relies on brake torque to tell the antiskid brake system when to apply pressure and how much, and it's possible that system would be somewhat more sensitive than present day systems, but we won't know that until we do tests at our track facility.

The other thing that we're going to be looking at later this year or early next year is a passive overrun material that, in the event the airplane does suffer a loss of braking or cannot stop on the pavement, this overrun area would be composed of material that would slow the airplane down from a hundred knots to a stop prior to either going into a river or going over a cliff.

There's been some work in this area by the FAA Technical Center about 10 years ago, where they came up with a foam concrete material. There's another development here in recent years where it's a material that's composed of both special soil and some composite material that offers even better stopping capability.

So, we're going to be looking at those two aspects in our work at NASA Langley, and by all means, we don't pretend to know everything there is to know about aircraft ground-handling performance, and it's from events like this and in discussions with the aviation community that we learn more about ways to improve airplane safety, and I'm -- I'm grateful to be a small part of that improvement.

Thank you.

CHAIRMAN HALL: Well, we appreciate your contribution, sir, and I think the -- we're going to hear more about the material that might be used at the end of the runways later, if I understand correctly, is that correct, and that was done in response to an NTSB recommendation that was made in the '70s.

So, I thank you for the kind remarks you made about our -- my investigators. I'm very proud of the work they do.

We have spent a considerable amount of time with this witness, but we've got all day. The National Weather Service has again, if you will look out the window, arranged to have weather that will keep us all trapped in this hotel. So, we may just go -- continue around the clock, but I want to be sure we have enough time to -- to -- you know, we've got important witnesses today, and I want to be sure that we have the time to -- give time to all of them that we need.

Why don't we take a break now and come back at half past the hour?

(Whereupon, a recess was taken.)

CHAIRMAN HALL: We will reconvene this hearing of the National Transportation Safety Board. I'd like to ask Mr. Berman if he would call our next witnesses.

MR. BERMAN: Our next witnesses will actually be this panel of three who will have questions addressed to them as a group, and I call Thomas Melody, C.J. Turner and Neal Gilleran. Would you please stand?

CHAIRMAN HALL: If I could please -- we've got -- we've reconvened. So, please, if you have conversations, if you need to take -- have them, take them outside the room, please. Thank you.

Whereupon,

THOMAS MELODY

having been first duly affirmed, was called as a witness herein and was examined and testified as follows:

Whereupon,

CUTHBERT J. (C.J.) TURNER

having been first duly affirmed, was called as a witness herein and was examined and testified as follows:

Whereupon,

NEAL GILLERAN

having been first duly affirmed, was called as a witness herein and was examined and testified as follows:

INTERVIEW BY TECHNICAL PANEL

MR. BERMAN: I'll ask all three of you the basic questions, you're probably used to them, in turn.

Mr. Melody, would you please state your full name and business address?

MR. MELODY: Yes It's Thomas J. Melody, and my business address is the Long Beach Division in Long Beach, California.

MR. BERMAN: And by whom are you employed?

MR. MELODY: Boeing Commercial Aircraft Company.

MR. BERMAN: What's your present position, sir?

MR. MELODY: I'm the Chief Pilot for Flight Operations, and the Senior Manager for Flight Operations in Long Beach.

MR. BERMAN: How long have you held that position?

MR. MELODY: For two months.

MR. BERMAN: Okay. What was the name of your previous position that you would have held at the time of this accident?

MR. MELODY: I was the Chief Test Pilot for the same company.

MR. BERMAN: Hm-hmm. And how long did you have that position?

MR. MELODY: I had that position for eight years.

MR. BERMAN: Thank you. Would you please briefly describe your duties and responsibilities of your current position?

MR. MELODY: In my current position, I'm now responsible for the supervision of all of the experimental test pilots, the Training Department, the Production Department, and the Customer Service Department.

MR. BERMAN: And do you cover all the Long Beach Division Products?

MR. MELODY: That's correct.

MR. BERMAN: Okay. Would you please describe your education, training and experience that qualified you for the positions you've had recently?

MR. MELODY: Yes. I have advanced degrees, Engineering degrees, both Aeronautical Engineering and Electrical Engineering. I was a graduate of and an instructor at the Air Force Test Pilot School, and I've been a test pilot at Douglas Boeing for the last 14 years.

MR. BERMAN: Thank you, sir. And could you please list your FAA airman certificates for us?

MR. MELODY: Yes. I have an airline transport pilot rating in the DC-9, DC-10, MD-11, and a hot air balloon rating.

MR. BERMAN: Okay. An ability go cope with hot air can be --

MR. MELODY: Yes.

MR. BERMAN: -- of benefit sometimes in proceedings. How much time -- flying time do you have in the DC-9 or MD-80 series, please?

MR. MELODY: Inhte DC-9 series, approximately 1,500 hours.

MR. BERMAN: Thank you. Mr. Gilleran, we'll go through the same routine. Could you please state your full name and address, business address?

MR. GILLERAN: Neal Patrick Gilleran, Long Beach, California.

MR. BERMAN: And by whom are you employed?

MR. GILLERAN: The Boeing Commercial Aircraft Company.

MR. BERMAN: What's your present position, and how long have you held it?

MR. GILLERAN: Currently, I am the Engineering Manager for Landing Gear, Brake and Hydraulic Systems. I've been in that position approximately eight months.

MR. BERMAN: Okay. Thank you. And what was your previous position?

MR. GILLERAN: The previous position was the same role for Landing Gear and Brake Systems.

MR. BERMAN: Okay. Would you please describe for me the duties and responsibilities of your current position?

MR. GILLERAN: Yes. I currently lead a small group of technical experts, primarily on the day-to-day production support and response to any in-service problems and backing up some of the investigation activity like we have here today.

MR. BERMAN: Okay. And could you describe your education and training and qualifications for your position?

MR. GILLERAN: Yes. I have a Bachelor's in Mechanical Engineering. I began my aviation career with the Douglas Aircraft Company, working on the analysis of brake system -- brake control systems. I subsequently was involved in the brake control system for the Lockheed L1011, wheels, brakes and tires for the Rockwell B-1, the Northrop F-5 braking system, and subsequently returned to the McDonnell Douglas Company, where I was closely involved with the MD-11 brake control system.

MR. BERMAN: Do you have an FAA airman certificate or any other relevant certification?

MR. GILLERAN: No, sir, I don't.

MR. BERMAN: Okay. Thank you. Mr. Turner, good morning.

MR. TURNER: Good morning.

MR. BERMAN: Please state your full name and address, business address.

MR. TURNER: Cuthbert J. Turner, 3855 Lakewood Boulevard, Long Beach, California.

MR. BERMAN: And your employer is?

MR. TURNER: Boeing, Long Beach Division.

MR. BERMAN: What's your present position, sir?

MR. TURNER: I'm a staff engineer in Aerodynamics.

MR. BERMAN: And how long have you been in that job?

MR. TURNER: One and a half years.

MR. BERMAN: Okay. Could you please describe your duties and responsibilities?

MR. TURNER: Okay. I deal with requirements and compliance and focusing mainly on FAA and JAA rulemaking for type certification and operation of commercial-type aircraft.

MR. BERMAN: Okay. And please describe your education and training and prior experience that qualified you for this position.

MR. TURNER: I graduated from Georgia Tech in 1966, and I've been working with the Douglas Company and McDonnell Douglas and Boeing ever since. I've worked primarily in the Aircraft Performance Group. I've worked on the DC-8, DC-9, DC-10, and MD-80 aircraft.

I was the Performance Group Manager for the MD-11 and MD-90 before my present position.

MR. BERMAN: Okay. Thank you. And do you have any FAA airman certificates or others?

MR. TURNER: No.

MR. BERMAN: Okay. Thank you, sir. Go ahead, Mr. Pereira.

MR. PEREIRA: Thank you, Mr. Berman.

INTERVIEW BY TECHNICAL PANEL

MR. PEREIRA: Mr. Gilleran, Mr. Turner, and Mr. Melody, I understand you have presentations on the subjects of MD-80 spoiler and auto brake systems, landing performance, and flight operations with respect to this accident.

Mr. Chairman, these subjects are all closely related. So, I'd prefer that the presentations be given sequentially with all questions held until after the last presentation.

CHAIRMAN HALL: I'll try to restrain myself. Please proceed.

MR. PEREIRA: Okay. The Boeing staff can proceed with their presentation.

MR. GILLERAN: Yes. May I have the first slide, please?

Let me begin by saying, first of all, thank you on behalf of the Boeing Company and all of my colleagues, both here and back at the Long Beach facility, who have worked hard on this investigation.

I want to say that we clearly recognize the importance and the value of this hearing, and we are hopeful that our participation can lead to an improvement in air travel safety.

Per the Board's request, our testimony today will concentrate on three aspects of the MD-80 aircraft. I will present a technical description of the spoiler and auto brake systems. Mr. Turner will focus on the measured stop performance and the effects of wet runway and lack of spoilers on the MD-80 stop distance, and Captain Melody will provide a presentation on the recommended operating procedures of the MD-80 aircraft.

Again, I will provide details on the MD-80 spoiler systems, speed brake and ground spoiler functions, and how the auto spoiler system works to interface with the spoiler system ground spoiler function, and, finally, the general arrangement and operation of the auto brake system.

The MD-80 has three spoiler panels on each wing. There are two flight spoilers, very weak red mark, but outboard flight spoiler and the inboard flight spoiler and one ground spoiler panel.

When raised above the wing's smooth upper surface, as shown on the right here, the spoiler panels reduce lift by disrupting the flow of air over the wing. Now, spoilers perform three functions on the MD-80. The first function is to provide lateral control in conjunction with the ailerons.

Secondly, the spoilers slow the aircraft in flight and aid descent from altitude and are called in this role speed brakes, and when used after touch down during a landing or in the event of a rejected take-off, spoilers cause a load increase on the landing gear and the tires. This load increase -- this load increases the maximum potential brake drag and is essential in obtaining the shortest stopping distance. This function is called ground spoilers.

The spoiler control system is a mechanically-operated hydraulically-actuated system consisting of levers, cables, pulleys and hydraulic components. Movement of the speed brake control panel located up here, generally referred to as the spoiler handle, operates the speed brake cables, which travel all the way down the fuselage, providing an input to the four flight spoiler actuators located on the two wings and the two ground spoiler control valves located within the fuselage.

Speed brakes provide symmetrical deployment of the flight spoiler panels to slow the aircraft in flight. The flight crew simply moves the handle aft in its stowed position here to the aft position here, actuating the rod, the sector and the cable system to cause the spoiler panels to go up.

The handle travel is physically limited to 35 degree travel for the purpose of flight spoilers. A rod attached to the sector actuates the speed brake valves or the speed brake switches in order to provide indication for the flight crew as to the status of the panels.

Now, the unshaded hardware shown in this diagram belongs to the auto spoiler system, and I'll get into those details in subsequent slides.

This is aschematic of the spoiler hydraulic system. Again, movement of the cables cause the force flight spoiler actuators attached to each of the flight spoiler panels to raise and lower the attached flight spoiler panels in proportion to the spoiler handle movement.

Now, there are two position sensors mounted on the right inboard flight spoiler panel and the left outboard flight spoiler panel. These position sensors provide information to the flight data recorder for the purpose of noting the position of the spoilers during, for example, an accident.

Manual deployment of the spoilers for the purpose of ground spoilers is done by first lifting the handle, then full movement aft, results in deployment of all spoiler panels to 60 degrees. The handle is held in the 60-degree position by the hook on the lock pin in the 60-degree position. Again, this is manual ground spoiler deployment.

Now, if a go-around is necessary, wherein a pilot has decided to take off immediately after a landing, advancing the left throttle will dislodge the handle from the hook, allowing the springloaded handle cable system and all spoiler panels to move to the stowed positions.

The flight crew can manually depress the spoiler handle, causing the handle to disengage from the hook and again returning all elements to their stowed positions.

To assure that the ground spoiler panels are not deployed inadvertently in flight, operation of each ground spoiler control valve, two valves here, requires both cable travel input combined with an electrical logic signal to allow hydraulic pressure to extend the ground spoiler cylinders and the attached ground spoiler panels.

The spoiler switches, noted earlier, provide information for operation of the three crew alerts, spoilers deployed, spoilers flap extended, ground spoiler and op, the master caution, and the central oral warning computer.

The auto spoiler system, as opposed to the standard mechanical spoiler system, provides quick, timely and full 60-degree deployment of all spoiler panels in the event of a rejected take-off and after landing touch down with minimal flight crew input.

The auto spoiler system operates the ground spoiler actuator, which is simply an electric motor in the left-hand side here, to extend the rod and rotate the drive crank. To enable the drive crank to perform its function of mechanically pushing the spoiler handle to the extent position, it is necessary to lift the spoiler handle into the armed position to engage the end of the drive crank with a rod for pushing the system.

Now, physical separation of the mechanical spoiler control system from the electronic auto spoiler system assures that a malfunction in the auto spoiler will not inadvertently deploy the spoiler panels in flight. This was a fundamental requirement with the system, when the system was designed in 1960, and remains so today.

Immediately after landing touch down, when two main gear wheels are spinning at approximately 70 knots or more, the ground spoiler control box will provide a 115-volt power to the auto spoiler switching unit, which in turn will actuate the ground spoiler actuator motor, causing the actuator to deploy the ground spoilers.

If the wheels do not spin up due to a slippery runway, compression stroking of the nose landing gear will close the nose landing gear switches also providing a 115-volts necessary to extend the ground spoilers.

If the auto spoiler do not use alert is illuminated in the cockpit prior to landing, the flight crew must deploy the ground spoilers manually upon landing.

This picture taken from the left seat shows the handle in the armed position. The spoiler handle displays a red area, if we can come in tighter on this, to both flight crew members as a visual check that the spoilers are in the armed position right here.

We have a short video of the activity involved in arming the spoiler handle. If we could switch to the video now, please?

(Video shown)

MR. GILLERAN: This is taken from the left seat I position, and you'll see here how the spoiler handle is armed by the right seat. Let's go to fast forward.

This was done on our fixed base simulator. So, there's -- the simulator is flying the airplane at this time. You can see the throttles move automatically, and the simulator is about to land the airplane, and upon landing, the spoiler handle will move to its full 90-degree position. Watch this handle right here. This is the spoiler handle. There is the deployment of the spoilers.

Now, we're going to advance the throttles, which disarm the spoilers, and then we're going to mechanically manually bring the spoilers back to their full armed position. Those are the motions that would take place in the cockpit relative to the spoilers.

Back to the slides, please. I'm going to switch to the auto brake system now. The MD-80 auto brake system provides a rapid and full application of the brakes in the event of an RTO and timely and consistent brake application in the landing mode.

Next slide. The auto brake control panel, upper left-hand side here, is located on the right side of the pedestal in the cockpit. The auto brake system is armed before landing by selecting the desired deceleration on the selector switch. For landing, it's min, medium and max, and momentarily depressing the armed switch to arm the system.

Then immediately after landing, when the spoiler handle is moved aft, either manually or by the auto spoiler system, the auto brake switches, located here, will initiate the automatic application of the brakes.

In the minimum and medium setting, the auto brake control unit will use information provided by the linear accelerometer unit to regulate the brake pressure coming out of the servo to achieve the desired deceleration programmed into the computer. If max has been selected, the control unit ramps the brake pressure to full 3,000 psi, maintaining the pressure until the system is disarmed.

If at any time the tires begin to skid, the antiskid will act independently to reduce the individual brake pressures in order to maintain optimum braking.

Now, the flight crew can disarm the auto braking function by thus returning brake pressure control to the flight crew by applying any brake pedal more than 25 percent or advancing any throttle or moving the selector switch to off or returning the spoiler handle to the stowed position.

In summary, ground spoilers reduce spring lift, thus increasing the vertical load on the tires needed to obtain the highest deceleration from the available runway friction. Arming of the spoiler handle is necessary to engage the auto spoiler mechanism for deployment of the ground spoilers, and maximum auto brake is recommended for wet runways to provide timely and consistent brake application and peak efficiency of the antiskid.

That concludes my prepared presentation. I'll turn it over to Mr. C.J. Turner, please.

MR. TURNER: The topics I will discuss are landing performance, operational information, effect of spoilers on landing performance, crosswind operation, effect of elevator on landing performance, and the effect of the event conditions on landing performance.

During the Flight Test Program, we demonstrate landing performance for the FAA. FAR Part 125A requires the distance to land from a 50-foot height to a complete stop. So, we measure this distance in two parts, an air portion, from 50 foot to contact, and then a ground distance, from touch down to stop. This becomes the demonstrated landing distance.

This is demonstrated on a dry, hard-surfaced runway.

The test conditions for these flights are forward center of gravity, which is the most critical, the speed at 50 feet is 1.3 times the stalling speed, which is referred to as VREF, the flaps for this condition were 40 degrees, was done on a dry runway. Auto spoilers were used. Pilot-actuated antiskid braking was used. There was no reverse thrust credit, and it was done over a range of weights representative of the airplane's landing weights.

The operating requirements in Part 121 provide additional safety margins over the demonstrated distance. Starting with the Part 121 landing distance, the FARs require that a safety margin be added to the dry runway distance for dry runway operation.

In the event that forecasts or reports indicate wet runway or slippery runway conditions may be present for landing, an additional 15 percent margin is added to the landing distance.

It must be verified before take-off that the runways at the destination airports will provide these margins. This was what Dispatcher William Trent referred to as far as the wet runway dispatch.

These margins address operational variations in speed, touch down point, runway surface conditions, tire conditions, temperature and up hill and down hill runway slopes.

The bar chart before you indicates the build-up of the minimum runway length required. These data are from the AFM or based on the AFM and at a landing performance at a 127,000 pounds which is the weight of the accident.

The first bar is the demonstrated distance. As we discussed, it consists of the air distance and the ground distance. The air distance is in this case 1,030 feet, the ground distance is 810 feet, for a total stopping distance of 2,830 feet.

The second bar is with a landing distance margin reflecting the factors required by Part 121. So, there, the 2,800 feet distance has now grown to 4,715 feet, and that would be the minimum length for a dry runway operation.

The next bar shows the additional 15 percent increase to provide landing margins required for a wet runway. So, the total distance there is a little bit over 5,400 feet.

Finally, the line on the right-hand side -- can you back up, Neal? I want to laze you. I guess we better not. The line on the right-hand side indicates the runway available at Little Rock. So, by these indications, there would be about -- approximately 1,800 feet margin between the minimum landing field length required and the runway available at Little Rock.

We've been asked to comment on the effect of spoilers on the weight on the wheels and on landing performance. We'll deal with the weight on wheels issues first.

The first bar chart is a plot of the estimated weight distribution of the airplane. There are three pieces. On the left is the left of the wing. The white bar in the center is the weight of the airplane that's supported by the main gear, and the dark area on the right is the weight of the airplane that's supported by the nose gear. They all add up to a 127,000 pounds.

We can see in this instance that the gray area, the left, is about 20 percent of the weight, and the white area, which is the weight on the main gear, which -- which is the gear that has the brakes, is almost 80 percent of the weight of the airplane. The black area is the weight on the nose gear, which provides steering and which has about three percent of the weight of the airplane.

The next case is landing with no spoilers. The big change is the increase in lift of the wing. The left now is supporting almost 70 percent of the weight of the airplane, and the main gear has only 30 percent of the weight. Now, these slides are showing conditions one second after touch down which is the highest speed where we'd have the highest lift.

As we proceed slowing down, there will be less weight on the wheels, but this was representative of the critical part of the landing.

The third bar shows the situation now with Reference B, plus the 20 knot adder that was added for the crosswind. The lift now is 90 percent of the airplane's weight, leaving only 10 percent to be distributed between the main gear and the nose gear. Allowing three percent on the nose gear for steering leaves us with only seven percent of the weight on the main gear.

This is very important for two reasons. The main gear will have less braking force when it has less weight applied. The second reason is that the main gear will produce less cornering force in a skid when less weight is applied.

We were asked to comment on the effect of nose-down elevator on weight on wheels. Applying aircraft nose-down elevator reduces the weight on the main gear and transfers it on to the nose gear. Since the nose gear doesn't have any brakes, the braking force on the vehicle is reduced, and that causes distances to stop to increase.

For a wet runway with no spoilers, stopping distance increases by approximately a 180 to 320 feet for five degrees of additional nose-down elevator.

We provided information beyond what's required in the FAA Operating Manual for operation of the airplane, and in order to produce this, we have to run some extra tests. We took the tests that we used for the dry runway landing distance, and we analyzed that to come up with a dry runway braking coefficient which we discussed -- Mr. Yager discussed earlier.

We run additional tests with no thrust reverse and no brakes to check out the aerodynamic drag of the airplane to be sure we understand that. Finally, we'll run tests with the reverse thrusts and no brakes to understand the effect of reverse thrust of the airplane.

Those items can be cobined in a computer simulation to create performance data for operational conditions where runway surface condition and aerodynamic configuration are different than what we demonstrate in the FAA tests.

In the Flight Crew Operating Manual, we'll have information regarding the minimum runway length for safe operation. This is essentially the same chart that the FAA requires be in the manual and be demonstrated with the factors. There will be some charts relating to the performance of the auto brake system and how to select a setting, depending on runway length.

The third chart is entitled "Estimated Effect of Runway Surface Condition and Reverse Thrust on Landing Distance". I'd like to show you a portion of that page from the FCOM.

This page provides information for both lightweight and heavyweight case, and these cases were calculated from the information with the extra tests we ran. The runway conditions on the left are shown.

The dark items, the dry, FAA dry and FAA wet, were numbers like I described, where, for instance, in the lightweight case, the 2,070 feet was the demonstrated distance, and then we factored it up for margins to 3,460 feet, and then for wet runway, we added the additional margins to 3,970 feet.

Compared to that, underneath is a wet runway calculated on what we believe to be our average operating conditions of 2,910 feet. In the right-hand column -- all those numbers I've described so far are forward idle thrust. In the right-hand set of columns, we've added some calculations with reverse thrust.

In the case of the wet runway, reverse thrust doesn't buy you much, only about 80 feet in the lightweight case. Now, in addition to the wet data, we've provided estimated data for snow and ice and for water or slush or some kind of standing water on the runway that might involve hydroplaning.

Based on the NASA testimony, we're not going to discuss those today. We'll discuss the wet runway and assume that's our operating condition.

Okay. The following information has been interpolated from the -- from the table for the case at hand, a 127,000 pounds. So, we have our FAA dry runway of 2,830 feet being factored up for the wet dispatch finally to be 5,425 feet, and a calculated wet number based on half the dry of being 4,040 feet with reverse -- without reverse, dropping to 3,915 feet with the use of 1.3 EPR reverse.

Okay. The next bar chart illustrates the effect of spoilers on landing performance. The first bar depicts the last case I just discussed in the table. The top bar, the gray bar, is with no reverse thrust, and the white bar is with 1.3 EPR reverse thrust, and those are our reference conditions that we started from from the table.

The bar we've added underneath now has no spoilers, and on the dry runway, we note that they are about 800 to 900 feet longer than the width spoiler cases.

The next case repeats the wet reference conditions with auto spoilers. The fourth bar depicts a wet runway with no spoilers, and these cases are about 1,200 to 1,500 feet longer than the wet runway cases with auto spoilers, and the no reverse case has actually used up the FAA field length margins, but at Little Rock, there's still 1,600 feet of field length available. But this gives us an idea of how important spoilers are to landing performance.

The next chart repeats these calculations at the reference speed plus 20 knots. The first line being dry runway performance with auto spoilers, adding a bar showing dry runway with no spoilers. Now, a wet runway with spoilers, and, finally, the wet runway without spoilers. These distances are about 2 to 3,000 feet longer than the cases with spoilers, and this is the first case where we've calculated distances that are longer than the runway that's available at Little Rock.

The event conditions differed slightly from the demonstrated performance in the following areas. The air distance, the distance from the runway threshold to touch down point was 890 feet longer than demonstrated in our tests. The application of the brakes were nine and a half seconds longer than we used in our landing dry runway demonstration. The ground spoilers were not deployed, and there was five degrees of additional nose-down elevator throughout a significant part of the run.

Based on these calculations, both cases exceed the runway available at Little Rock. The case with no reverse thrust would have left the runway at a hundred knots.

This concludes my presentation.

MR. MELODY: Good afternoon. What I'd like to talk about today to address the Airplane Flight Manual approved by the FAA and the Flight Crew Operating Manual which is part of our Approved Training Program, Training Program that we have to have approved by the FAA for each operator, and the Flight Crew Operating Manual is indirectly approved by the FAA because it is approved as part of our Flight Crew Training Program.

Those manuals contain examples of operating procedures, and I'd like to just go over a couple of those operating procedures as part of examples of what's in that manual.

I'd like to address the issue of crosswind landing techniques, compare that with the auto land technique, and give you some examples of additional guidance that we put out to the operators, in addition to the Flight Crew Operating Manuals.

I'd like to address the issue of the aerodynamic forces that are present during a crosswind landing and discuss why we recommend that the MD-80 not be landed in a crab and also then discuss the issue of rudder effectiveness during reverse thrust operation.

The FAA-approved Flight Manual is a manual that we developed during the development portion of the Certification Program. The manual actually contains sections on limitations, emergency and normal procedures, and a complete volume on performance data.

I'd like to point out that the only portions of the approved Flight Manual that are mandatory, that must be included in our FCOM, that must also be included in the FCOM of the different operators, are the Limitations Section and the Performance Data.

Just for therecord, because this issue will come up, I'd like to read the paragraph in the AFM dealing with procedures.

"The Operating Procedures contained in this manual have been developed and recommended by the manufacturer and approved by the FAA for use in the operation of this aircraft. These procedures are only for guidance in identifying acceptable operating procedures and are not to be considered mandatory or in any way construed as prohibiting an operator from developing his own equivalent procedures."

Now, I'd like to talk a little bit about the Flight Crew Operating Manual or FCOM. This is the manual that we use primarily in our Training Program and in establishing training programs for the different operators.

The FCOM is a guideline for the operators, and I would like to point out that in general, the operators will use our emergency procedures. However, some of their operating procedures may be different. I can give you examples.

There are taxi -- for individual operators, the taxi procedures might be different. Air conditioning system procedures might be different. The system operations procedures may vary from operator to operator, and they may prefer to keep those procedures common, to be common with other aircraft fleets.

We do send updates to the operators, the subscriber operators, of any changes that we propose in our FCOM. Those procedures are sent to the operator. It's the operator's responsibility to coordinate those with their operating POI.

The operating procedures, as I mentioned, that we develop for our FCOM from the AFM, is not obligatory on the operators, and therefore the operator, in conjunction with the POI, may change those operating procedures.

Once the airplane receives its standard C of A, Certificate of Airworthiness, the airplane now falls under the operator's operations specification, and it is between the operator and their POI to obtain approval for any changes.

Having said that, most domestic operators, in fact, if not all domestic operators, will coordinate with the manufacturer before they make any changes to their -- their own FCOM, and normally that's done in the form of a letter of no technical objection.

The FCOM is basically divided into three volumes. Volume 1 is the Abnormal and Emergency Procedure Book. It is used to define mandatory items, and those would be for the emergency procedures.

However, the vast part of the Volume 1, the Emergency and Abnormal Checklist, is for abnormal situations that don't require action directly from memory. The airplane is designed to be operated safely, even with malfunctions, and the normal procedure would be for the pilot to continue to maintain aircraft control. The non-flying pilot would get out this volume, and then they would coordinate going through the steps necessary as a result of whatever abnormal situation occurred.

Volume 2 is our Normal Operating and Abnormal Operating

Expanded Procedures along with the System Description. The Volume 2 adds notes about why we have adopted certain procedures that would help the pilot understand why we're doing certain things.

The System Description is there to enhance the operator's knowledge and understanding of the airplane to enhance safety.

Volume 3 and subsequent are the Performance Documents. There are usually more than one because we provide the performance data to different operators using metric systems or English systems. So, the data comes in many different formats, and that explains why subsequent -- but Volume 3 would be the beginning of the performance data.

The data contained in this volume of the FCOM, as Mr. Turner said, is the data that we obtained during the aircraft certification. The FAA-approved data, as I just mentioned, is mandatory in all operator FCOMs.

Now, I'd just like to go over a review of some of the types of procedures that we're talking about that we include in our FCOM. Flight Control Use During Landing Spoiler Operation, one procedure is to lift the handle and ensure that the spoilers are armed, and the next one is to ensure that during landing, that the spoilers -- if the spoilers retract, the auto brake system will disarm.

So, it's just a reminder that if, for some reason, the pilot lands with the throttles above a certain position, the spoilers will start to deploy, but they will immediately retract and that will disarm the auto brake system.

Another procedure listed in the Landing Section of our book has to do with the spoiler fails to deploy, and our book says, "If the spoilers fail to deploy after landing, the pilot not flying shall call no spoilers. The pilot flying shall move the spoiler to the full aft and up position and latched."

I might point out that as a result of a question that occurred, I believe, yesterday, the procedure to do this is in our manual, dating back to 1991, and I'll also point out that the outboard spoilers are required for dispatch.

Okay. We have another procedure that we recommend that involves in the case of landing on a dry runway, we recommend that the reverse thrust power lever not exceed 1.6 engine pressure ratio, EPR, and the term was used yesterday. It's basically the pressure ratio of the air at the exhaust compared to the air at the inlet. It's a fairly good measure of thrust.

On dry runways, we recommend limiting that thrust on each engine to 1.6 EPR. However, on contaminated runways, we recommend that the pilot not use more than 1.3 EPR, except in an emergency, and I'll discuss the reason for those two numbers shortly.

Another procedure relates to landing rolls and difficulty in maintaining directional control. In the event that the pilot experiences difficulty in maintaining directional control, we recommend that he come out of reverse thrust to reverse idle and then to forward idle, if necessary. Do not attempt to maintain directional control using asymmetric reverse thrust, and I'll talk about that shortly, also.

Another procedure deals with the arming of the auto brakes, and we will discuss that under some conditions, we do recommend using auto brakes, and as Mr. Gilleran pointed out, there's a rotary switch on the panel that you can rotate to the desired position, and then momentarily move the arm switch to the armed position, and I will point out in the auto brakes, we do have three positions.

The minimum and medium will give you an operator-selected deceleration rate. So, that's based on deceleration rate, and in the maximum position, the full hydraulic pressure is applied to all brakes.

Another procedure -- and by the way, these procedures are all listed as paragraphs in a section of the book in the Volume 2, Normal Operating Procedures, under Landing. So, all of these paragraphs would be a list of paragraphs contained in Volume 2 dealing with procedures for landing.

Now, we further expand on landing on contaminated runways, and we recommend the use of max auto brakes, if available. However, as part of our techniques, both for landing on contaminated runways and initiating RTOs on either dry or contaminated runways, once the auto brakes are initiated, we recommend that the pilot apply full smooth symmetrical braking and maintain braking until stopping is assured.

Another procedure discussed in the book is the use of the elevator during -- during landing roll-out. We do recommend that the column be pushed forward to ensure the maximum nose wheel contact to ensure a maximum nose wheel steering efficiency.

However, we do make a comment that too much nose down pressure will unload the landing gear, resulting in slightly longer landing distances.

We have another note in that same section that is advising pilots if landing is planned on contaminated runways with snow, slush, standing water or during heavy rain, there are factors which they should consider that may impact the landing, and those factors would include visibility of runway markers and lights, wind direction and velocity, crosswind effect on directional control, and braking action, and the probability of hydroplaning, and the effect of hydroplaning on stopping distance.

Another operating procedure that we recommend is if a skid develops, we recommend that you release the brakes, reduce reverse thrust once again to reverse idle, forward idle, if necessary, apply rudder as necessary to regain directional control, and then reapply the brakes and thrust reverse as required.

The next subject now I'd like to talk about are various crosswind landing techniques. It's -- it's been an issue that I suppose has been discussed quite a bit. For the Long Beach Division products, we recommend landing in a side slip. That's the landing technique we use for both the twin jet DC-9 family, the DC-10 and MD-11.

We recommend landing in a slip. What the slip will do is it will not only align the direction that the airplane is moving with the runway direction, but it also aligns the nose of the airplane with the runway direction.

So, in other words, with the crosswind, we have to lower the upwind wing into the wind, and, of course, without applying any rudder, that would cause the airplane to start turning into the wind. So, then we use opposite rudder to align the nose of the airplane with the runway.

So, with this technique, we land a little bit upwind wing down, but we land with the nose going straight down the runway, and the airplane going straight down the runway.

The advantage to that, of course, is that if you land in a slip, you will not be in a crab, and, so, later in this briefing, we'll talk about some of the disadvantages of being in a crab.

Now, a different landing technique used by some airplanes is to land in a crab. Now, a crab, as we'll see on one of the next few slides, a crab is the angle between the nose of the airplane, where the airplane's pointing, and the direction that the airplane's actually going.

So, its name not coincidentally comes from the motion of a crab. The airplane is pointing slightly at a different angle from the direction that it's going, and that's a landing technique that -- that some airplanes do use. The MD-80, however, does not recommend that technique.

Now, I mentioned, excuse me, that I'd also talk about the auto land techniques, and now we're talking about the technique that's used by the auto pilot during an auto land, and not by coincidence, the auto land is designed to land using the side slip technique just like we use when we land manually.

So, in the case of the MD-80, at a 150 feet above the runway touch down elevation, the airplane will go into what we call the align mode. It will lower the upwind wing just enough and apply just enough rudder so that the airplane is pointing down the runway and is not drifting, and that is the auto land technique. It's the same technique that we teach people manually.

One final point I'd like to talk about before I go on to talk about why we recommend not landing in a crab is we do provide other sources of information, in addition to the information I've just discussed in the Flight Crew Operating Manuals, which we do forward to the operators.

In addition to that, when we become aware of any events or as a seasonal issue, when we know that certain seasonal situations will tend to require increased awareness, we do send out a series of different types of correspondence.

All operator letters would -- would be sent to all operators of a particular piece of equipment, and we did send one out in 1996 dealing with handling characteristics when landing on wet or slippery runways. We sent out a flight crew newsletter which was more of the seasonal bulletin. This is a repeat of a document that we've been sending out periodically since the mid-1970s.

Some of these issues never change, and then, recently, we've adopted another form of correspondence known as a Flight Operation Bulletin, and it's sent from the Boeing Flight Operations to the Flight Operations Departments of all the operators, and most recently, we sent one out in January of 1999 dealing with directional control during landing with the thrust reverser inoperative, and we also covered in that

Operations Bulletin the impact that a wet runway would have.

Now, I'd like to switch subject areas a little bit and talk about the aerodynamic forces that impact the airplane when landing in a crab. I certainly -- in this briefing, I was asked to brief this particular subject. I don't want to imply in any way that the accident airplane landed in a crab. So, please don't draw any conclusions from -- this is more of an academic briefing, and it has no relevant connection to the 1420 accident.

We have for probably the last 30 years and probably more, probably since the beginning of the jet age at Douglas, we have recommended that the airplane not be landed in a crab. In other words, not be landed with nose at an angle to the runway, and not only is it important that the airplane not be landed in a crab in our opinion for our airplanes, but it's also important that it not be allowed to get into a crab on the runway.

Now, ironically, on the runway, we refer to it as a side slip, but I don't want to confuse the issue there that side slip technique for landing, and being in a side slip or, as has been previously mentioned, in a yaw angle. So, those terms are somewhat synonymous, being in a slide slip, being in a crab or having a yaw angle.

Anyway, as I mentioned, the Boeing Douglas heritage philosophy for those airplanes has always been to land in a -- in a side slip.

Here are three of the forces that I'm going to be discussing as why we recommend not landing in a crab, and in addition getting out of a crab as soon as possible, if one develops on the runway.

We'll discuss the impact of the reverse thrusters. We'll discuss the impact of the rudder, and we'll discuss the aerodynamic drag that's acting on the airplane as a result of being in a crab.

The first thing I'd like to talk about here is an airplane in a crab, and in this case on the runway. So, this could be at the point of touch down or really at any point after touch down, but basically here's the crab angle I was talking about.

The direction of travel is this way. The airplane is going straight down the runway. However, the airplane is pointing at an angle to the runway. So, this angle, which is this angle, is the crab angle.

Now, what I'd like to discuss is when -- when the pilot puts the engines in reverse, okay, we have reverse thrust forces that act parallel to the airplane's center line. Those forces can be broken up into components, components which are parallel to the runway, and then components that are perpendicular to the runway.

Now, clearly, the component of the reverse thrust that is parallel to the runway will provide a stopping force to decelerate the airplane. The components that are perpendicular to the runway add nothing to the stopping performance of the airplane.

What they do do, however, is force the airplane in the downwind direction. So, if the airplane is pointing into the wind, these side force components will have a tendency to move the airplane downwind, in addition to whatever other forces are acting on it, but this thrust force will force the airplane down -- downwind.

Now, what I'm going to show you on the second slide, and I don't want to show it just yet, is that because of that configuration -- could you put that slide back up, please?

Because of the tail-mounted configuration, there's a lot of misunderstanding about the impact of these side forces. A lot of people think that because the engines are mounted on the tail, that these side forces are pushing the tail, in this example, pushing the tail to the right.

Well, that's not true. Force is a sliding vector, and in fact, the impact of this force on this airplane would be exactly the same no matter where that force was applied to the airplane.

If the reverser were right here on the wing, it would have the same effect. If the reverser were up here on the nose, it would have the same effect. So, what I want to make sure that -- that everybody understands is that the significance of having the engines back here, that does not mean that the side forces are acting on the tail.

Okay. Now, -- I'm sorry. This would be the correct way to analyze that reverse thrust situation. When we move the thrust reverse forces, move both forces to the CG of the airplane, now we see we have still a net force in the aft direction down the runway, and that's the sum of the two forces that were previously going aft here, and we have a net force pushing the airplane down the runway, and that's the net force of the two side forces we had back here.

In moving those forces, though, we have to -- we have to create a couple, a couple to show the actual yawing moment that would have been created by those forces. So, now we show that we have a couple. By moving this force back to this CG, we create a couple in this direction. By moving this force back to the CG, we create an opposite couple.

So, my point is that with symmetrical reverse thrust, there is no yawing moment. There is no tendency because of being in reverse to yaw the airplane. Okay. I think that's a very important point.

Now, on the other hand, ifthe reverse thrust was not symmetrical, if the reverse thrust was not symmetrical, there would be a yawing force, but because the moment arm from the center line of the engine to the CG, the lateral CG of the airplane is relatively short, the yawing moment, due to asymmetrical thrust in the MD-80s, is fairly small, much smaller than it would be on a larger airplane with the engines mounted much further outboard.

What I'd like to point out here then is the aerodynamic effect of the air flow going over the vertical fin and the rudder combination. So, the only point I'd like to make here is when the airplane's going straight, when it's not in a crab, the air flow on both sides of the vertical fin and rudder are symmetrical. There's no net force being generated on the rudder at all or on the -- on the stabilizer on the airplane.

Now, this slide demonstrates, and I'm afraid it might be a little hard to see, but -- but even now, in the same scenario where we're going straight down the runway, where we have no crab, if we deflect the rudder, if we deflect the rudder, if we deflect the rudder, it generates an increase in air flow over the upper surface.

In this case, for those of you familiar with this, you can see this really just like a wing. So, we increase the air flow, thereby reducing the pressure on this surface, and by having more pressure here than you have here, it generates a force to push the tail in this case to the left, pushing the nose of the airplane to the right. That's how we steer on the runway using the rudder.

Now, it becomes a little more complicated when we're in a crab. Now, in this scenario, you can see that the rudder is in the correct direction for what we recommend. What we recommend is that the rudder be applied to align the airplane with the runway direction.

So, in this case, with the crab being to the left, our recommendation would be to use the right rudder, thereby creating a force on the vertical fin that would move the tail back up toward the center line, move the nose back toward the center line.

Now, the other thing that you can see from the slide, there is another set of forces acting in this direction to push the tail to the left, and that's what we call directional stability.

So, in this case, with the rudder to the right, in a left crab, we have two things acting in our favor. We have the side force due to rudder, and we have the side force due to the natural directional stability, what we call CN Beta, and that would be the proper thing to do.

Now, what we have seen at other times is putting in the left rudder in an attempt to get back to center line, and that would create a force that would push you further toward the side of the runway, and at the same time reduce your directional stability.

Okay. Now, this slide shows the aerodynamic forces acting on the airplane, and I want to stress that very carefully because if you were here for the previous presentation, you realized that getting into any discussion of ground dynamics would be very, very complex, and -- and it's way out of my -- my category.

So, I don't want to get into the ground dynamics, the ground reaction forces, other than to say they are there. They're very complicated. In this scenario, the ground forces would be trying to keep the airplane from moving toward the end of the runway, and the ground forces on the tires would have a tendency to snap the nose back to the right, but I'm not knowledgeable in that -- that area. So, I'm limiting my discussion to the aerodynamic forces on the airplane when it lands in a crab.

What happens now is that when you land in a crab, with the wind direction imposed over that, that the wind direction, the total free-strain velocity, what we call the free-strain velocity, that's the air mass moving in the direction opposite to the airplane, the -- the free-strain velocity will be such that you'll have a component -- now, if this is the free-strain velocity, you'll have a component parallel to the runway and a component once again perpendicular to the runway, and, so, that force is going to also try to push the airplane to the side of the runway.

That's -- you know, everybody just assumes that when you're landing in a big wind, that wind has got to be moving you, and it certainly is, and this is really a simple way to explain that, but I don't want to oversimplify the fact that I'm not discussing ground dynamics here at all.

Okay. Just to summarize then, the landing forces, and I should caveat that with landing forces due to aerodynamic effects and thrust effects, and, so, you see what we have here is the reverse thrust component pushing the airplane to the side of the runway. The drag force component due to landing in a crab forcing the airplane to the side of the runway, and then we have the -- the drag force component, in this case due to the parasite drag, that's the drag that's due to the movement of the airplane, and the drag force component due to the aerodynamic forces acting on the airplane.

Now, those -- these forces -- these forces here are good forces. These are helping us slow the airplane down. These forces aren't doing anything to help slow the airplane down. They're -- these forces are causing the airplane to accelerate in one direction or the other relative to runway center line, and you can see here that the rudder force component by itself, which in the example we used was the correct rudder, has got to balance out the reverse thrust component and the drag force component by being in a crab.

Now, in order to give the rudder force all the capability and effectiveness that -- that we can, that's why in our earlier procedures, we recommended if you're having directional control problems, come out of reverse thrust until you regain directional control, and also in order to eliminate this side force component, that's why we recommend not being in a crab, and to help not being in a crab, we recommend you don't land in one.

Now, the one final subject that I would like to discuss is rudder effectiveness during reverse thrust operation. All MD-80 operators are familiar that over the years, we've put out information about rudder effectiveness in the MD-80 particularly, and why this does have an impact on our directional control.

As you can see here in the first bullet, clearly the thrust reversers are there to help the airplane slow down. There is a -- an impact on that ability of the rudder to steer when the thrust reversers are being used, and that's because the thrust reversers, because they're buckets, they're clam shells that open up and redirect the air flow, it's a pattern known as eflux, and that has an impact on the aerodynamic flow over the rudder and fin.

When I showed on an earlier slide that when the airplane's going straight down the runway, the air flow on both sides of the rudder and fin are symmetrical, then you have complete rudder effectiveness, but if you start disrupting the air flow over the vertical fin, you start losing some of that rudder effectiveness, and, so, because of that, we do have two recommendations for the EPR setting used on landing, 1.6 on dry runways, 1.3 on wet runways.

So, I'd like to just show you what -- what's the effect here. When you open the reversers, the reversers are clam shells that kind of open up this way and open up this way, and what they do is they deflect the air coming through the engine, which is at fairly high speed. They deflect that air up and down in a manner like this, and that's known as the eflux field.

This eflux field up here has an impact on the air that would be normally flowing in a streamline across the vertical fin and rudder combination. Because of that, it will start to create a field of air flow that would be turbulent and not -- and not laminar, like we'd prefer to have over the air flow.

So, you get turbulent air flow over here, and the rudder loses its effectiveness. This phenomenon on the MD-80 generally occurs somewhere around a hundred knots, between 90 and a hundred knots.

If you have 1.6 EPR, between 90 and a hundred knots, you're going to lose directional control of the rudder. So, that's the other reason we talk about during the D cell, if you're having trouble with directional control, come out of reverse thrust, not only because of the side force issue but also because of the rudder effectiveness.

So, once you get -- once you get the airplane with -- with going in the direction you want it to go with no more directional control problems, then you don't need to apply the rudder, and, so, then you can reapply reverse thrust as we mentioned.

In summary then, the two basic parts of the briefing was to discuss the AFM, the FCOM, and the other guidance materials we provide for flight crews for safe operation, and also an understanding of the aerodynamic forces acting on the airplane during landing to enhance the flight crew's ability to cope with a variety of conditions.

Sir, that concludes my presentation.

MR. PEREIRA: Thank you very much.

CHAIRMAN HALL: Charlie, how long are your questions? I'm trying to make a lunch decision here.

MR. PEREIRA: I would estimate that I have, including the answers, probably half an hour. 20 minutes to half an hour.

CHAIRMAN HALL: Well, let's take lunch, and knowing that, that's usually -- we would add a factor of approximately 15 to 20 percent, I think, to what Mr. Pereira's -- 50 percent? So, we will -- we will go take our lunch break and come back promptly at 2 p.m.

MR. PEREIRA: Is that a dry or wet estimate?

(Whereupon, at 1:00 p.m., the hearing was recessed, to reconvene this same day, Friday, January 28th, 2000, at 2:00 p.m.)

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

2:00 p.m.

CHAIRMAN HALL: We will reconvene this hearing of the National Transportation Safety Board, and, Mr. Pereira, you can commence with your -- what was it -- 10 minutes of questions? Whatever it is, whatever you need to ask. Go as long as you need to. It's a no-fault policy when it comes to staff on questions.

MR. PEREIRA: All right.

Whereupon,

THOMAS MELODY

having been previously duly affirmed, was called as a witness herein and was examined and testified further as follows:

Whereupon,

CUTHBERT J. (C.J.) TURNER

having been previously duly affirmed, was called as a witness herein and was examined and testified further as follows:

Whereupon,

NEAL GILLERAN

having been previously duly affirmed, was called as a witness herein and was examined and testified further as follows:

INTERVIEW BY TECHNICAL PANEL

MR. PEREIRA: Mr. Gilleran, would you please turn to the Exhibit 10D, Page 7? It's the previous landing FDR data that we talked about earlier. I believe you've got a plot of it in the back ready to go.

MR. GILLERAN: Yeah. We can get that up on the screen, I think, would be the best way to look at it.

MR. PEREIRA: This is for the previous landing. Would you please point out the spoiler parameters? This is from the flight data recorder data.

MR. GILLERAN: Yes. If you'll recall, we have two transducers, one on the left outboard and one on the -- on the right outboard, one on the left inboard, one of those combinations.

The two traces right here, I believe, a little fuzzy, but those are the two spoilers. You can see -- there, that's good. You can see them both deploying immediately after touch down and deployed to a full 60-degree position all the way through the run, until the pilot commands the spoilers to go back to their stowed position.

MR. PEREIRA: And this is the prior landing?

MR. GILLERAN: Yes.

MR. PEREIRA: And is this an example of normal ground spoiler deployment?

MR. GILLERAN: Yes, definitely.

MR. PEREIRA: Okay. Could we go to the same plot for the accident? I believe it's Page 3 in the same exhibit. Can we focus in on the spoiler parameters?

MR. GILLERAN: In this area here. The right inboard spoiler and the left outboard spoiler, you can see small motion due to aileron inputs. If we now move the slide to the right, you can then see here the right inboard spoiler as a full deflection of 60 degrees. This was a problem. This was due to full aileron deflection, full turn of the steering yoke in the -- in the cockpit would cause that spoiler to go to that position momentarily and then retract again.

MR. PEREIRA: So, would this be indicative of the ground spoiler's functioning or the flight spoiler or --

MR. GILLERAN: This would be the aileron function for the spoilers.

MR. PEREIRA: Okay.

MR. GILLERAN: And it would be one of the flight spoiler panels going up in response to an aileron input.

MR. PEREIRA: Okay. Does this indicate that the -- these two spoiler parameters on the flight recorder are functioning normally?

MR. GILLERAN: Yes, it does.

MR. PEREIRA: And recording the data apparently normally?

MR. GILLERAN: Yes, it is.

MR. PEREIRA: Okay. Now, if the spoilers had been -- the ground spoilers had been deployed in this accident landing, what would we expect -- have expected as traces to look like?

MR. GILLERAN: They would have been a straight line at the 60-degree point. This is one of them, and the other one would have been up to this line, right from the beginning of the touch down.

MR. PEREIRA: Okay. So, do you have any evidence that the spoilers were functioning properly or -- or improperly?

MR. GILLERAN: Well, --

MR. PEREIRA: The flight and ground spoilers?

MR. GILLERAN: -- the only evidence is that the -- that the spoilers were functioning here from control wheel inputs. They were functioning on the previous landing, and there was no report of any alert indications from the flight crew prior to the landing.

MR. PEREIRA: Okay. Thank you.

MR. GILLERAN: Other than that, there is no way in the FDR data to tell that the spoiler system is fully functional.

MR. PEREIRA: Okay. Is there any cockpit oral, visual or other warning after landing that the spoilers are not deployed?

MR. GILLERAN: No. The only warning to the flight crew is the motion of the handle, which is quite extensive. There is also quite a bit of sound associated with that handle clanking into its position. Also, there is a spoiler actuator motor, has a whirring noise associated when it moves. So, there is some -- the visual indication of the motion, plus the mechanical noise associated with the mechanical system.

MR. PEREIRA: So, if you don't hear or don't see those things, that would be a cue to you that it's not functioning properly?

MR. GILLERAN: Well, I think this is why in our training, we emphasize that the pilot not flying should be keeping an eye on that handle to be sure that the spoiler handle has moved to the extend position.

MR. PEREIRA: And that's why you have the FCOM procedure to that effect?

MR. GILLERAN: Yes.

MR. PEREIRA: Okay. Okay.

MR. MELODY: If I could -- excuse me. If I could just expand on that a little bit more. There is one other indication that you can normally count on when the spoilers deploy, especially if you've made a nice smooth landing. You know, if you touch down very lightly two to three feet per second, and then when the spoilers deploy, suddenly the airplane just sinks another, you know, 10 to 12 inches, and that's very, very noticeable, and it -- and it's really an annoyance when you think you've made a beautiful landing.

If you land firmly, you never feel that, but if you just land very lightly, when the spoilers come up, the airplane settles. That's that big loss of lift that we've been talking about, and you -- you can feel that.

MR. PEREIRA: Now, in this case, we had approximately 1.7 g, I believe, touch down. Would you expect to feel that?

MR. MELODY: No.

MR. PEREIRA: Okay. What airplane system and human failures can result in a lack of spoiler deployment during the landing of an MD-80, and what MD-80 design features or operational procedures help prevent or account for such failures?

MR. GILLERAN: Charlie, would you repeat that question again, please?

MR. PEREIRA: Okay. What airplane system and human failures can result in a lack of spoiler deployment during the landing of an MD-80? I'll leave it at that for now.

MR. GILLERAN: Okay. Let me take that question. I think, first of all, the system, because of its simplicity and from its basic design philosophy, it has been very reliable.

The -- the only human factor that really is involved here is to arm those spoilers, and to be sure that the auto spoiler system then can successfully engage and actuate the spoiler system itself.

From an operational point of view, the combination of getting the tires to spin up, you could have a situation where those tires would not spin up, and, of course, that's why the system has designed into it compression of the nose gear as the back-up signal to be sure that the spoilers will deploy shortly after or immediately after the nose gear has touched down.

There are other things that can go wrong, of course. Wires broken, things like that, but, generally speaking, this system, as simple and as reliable as it is, it has been a model of a good system in my opinion.

MR. PEREIRA: So, if you had the spoilers armed and touch down, and for whatever reason didn't get tires spin up, and the nose gear compressed, you would still get automatic spoiler deployment?

MR. GILLERAN: That's correct.

MR. PEREIRA: Okay. If you could turn to Slide 10 from your spoiler presentation concerning the ground panel interlock and indications.

MR. GILLERAN: Yes.

MR. PEREIRA: Down in the text portion, if you have it.

MR. GILLERAN: Hm-hmm. We don't have the text --

MR. PEREIRA: Okay.

MR. GILLERAN: -- portion, but go ahead.

MR. PEREIRA: It lists in the text portion of the Exhibit 13C, Page 10, three electrical signal requirements for ground spoiler actuation. The landing gear handle switch closed and in the down position. Left to right main landing gear wheel signal received on the proximity system, and left throttle switch closed in the idle position.

Did we satisfy all of those conditions in this landing?

MR. GILLERAN: Let me take -- first of all, let's explain this. This electrical interlock function -- have the chart back up, please, -- is only for the ground spoiler panels. It does not interlock the flight spoiler panels. The two here and the two up there.

Now, the reason that this feature is in there is to assure that inadvertent deployment of the spoilers in flight or shortly after take-off, which would be a serious consequence for the aircraft, cannot occur.

So, this logic only controls the two inboard ground spoiler panels. If the flight spoiler handle moves to the ground spoiler position, you would still get the flight spoilers, but you would be inhibited by this electrical signal which takes three things then to allow those ground spoiler panels to deploy.

The landing gear handle switch would be in the down position, and the left or right main -- and, of course, for this landing, it was. The left or right main landing gear weight on wheel signal received from the proximity system would pull some of these relays in, and based on the runway track, marks on the runway, we feel that the main gear was getting some compression. Those switches are set at a very short stroke of the main gear, and they should have thrown in this situation, and then, secondly, the left throttle switch closed in the idle position.

We can look at the FDR data, and we're relatively confident that the throttles were in the idle position, if for no other reason than that the reversers were pulled almost immediately upon touch down.

MR. PEREIRA: Okay. So, if I understand this, even if you had one of those or all three of those conditions not met, we would have still seen the other spoiler panels come up to full 60 on touch down on the FDR?

MR. GILLERAN: If it had been armed when the automatic spoiler system pushed the handle, you would have seen the flight spoilers recorded on the FDR.

MR. PEREIRA: Okay. Thank you. Is there any operational history of the ground spoiler failure?

MR. GILLERAN: Well, the number of switches that are involved, proximity switches and relays, can lead to the ground spoiler panels not deploying each time, which would take perhaps 20 to 30 percent of the reduction in lift would be eliminated. You would still have the flight spoiler panels reducing the lift significantly.

I don't have any data as to the number of times that the ground spoiler panel interlock has been a problem at this point. Generally speaking, I don't think -- this is a very mature aircraft. Most of those kind of things have been addressed in order to maintain the high dispatchability of the aircraft.

MR. PEREIRA: If such a failure like that did occur, would the handle still come back in the cockpit, and would we still likely hear that on the CVR?

MR. GILLERAN: Yes, you would. Yes.

MR. PEREIRA: Okay.

MR. GILLERAN: The fact that the ground spoiler panels were inhibited would not immediately show in the cockpit.

MR. PEREIRA: Okay. Is there any ground spoiler deflection indicator in the cockpit? Is there a dial gauge or anything that shows 60 degrees?

MR. GILLERAN: I don't believe so. No, there is no indication of the spoiler position.

MR. PEREIRA: Okay.

MR. GILLERAN: That is a factor. There is no indication in the cockpit.

MR. PEREIRA: Other than the handle itself?

MR. GILLERAN: Right.

MR. PEREIRA: Okay. If -- if a pilot fails to arm or flight crew fails to arm the spoilers, are there any MD-80 design features to help prevent or account for such failures?

MR. GILLERAN: Specifically, failure to arm the spoilers, there are no design features in the system. The system has been improved significantly over the years. A number of changes have been made since it was first conceived back in 1960, but most of the changes have gone to assure that the spoilers do not deploy inadvertently in flight, this being the most critical thing that could happen to that system and could cause a very serious accident.

So, over the years, the attention has been to be sure that the spoilers deploy -- do not deploy inadvertently.

MR. PEREIRA: Okay.

MR. MELODY: If I could add to that, the -- the indication that the spoilers are armed are that rather large red band, and in our procedures, during the before landing checklist require both pilots to acknowledge that the spoilers are armed.

MR. PEREIRA: In your FCOM before landing checklist?

MR. MELODY: That's correct.

MR. PEREIRA: Okay. Do you know -- are you familiar enough with American Airlines Ops Manual to know whether that's reflected in their manual?

MR. GILLERAN: Tom?

MR. MELODY: I believe in the American Airlines checklist, the non-flying pilot performs the before landing checklist, and there's only at this point in time two actions where both pilots acknowledge, and it doesn't include the spoilers.

MR. PEREIRA: Okay. Thank you. Are you aware that some Boeing airplanes, such as the 757, will deploy the spoilers when the thrust reversers are deployed, regardless of whether or not the spoilers are armed?

MR. GILLERAN: Yes. I've just recently become aware of that. Let me -- let me explain that just a step further. All Boeing airplanes, both pre-merger airplanes and the current ones, all require arming of the handle to get the full function of the automatic spoilers.

Now, in the newer aircraft, where we have the flexibility perhaps of software and digital-controlled devices, you can add additional features, such as using the -- the reverse thrust switches, to correct for a situation.

In this particular system, the auto spoilers would have already functioned due to the touch down and would have gone to the 60-degree position for the auto spoiler, leaving the mechanical handle behind, if you will, and you can't go back with the auto spoiler system and pick it back up.

So, it would be very difficult to incorporate that into a mechanical system of this design.

MR. PEREIRA: Okay. That was my next question. Has Boeing given any consideration to changing the MD-80 and other Boeing aircraft that are not so configured to operate in that manner?

MR. GILLERAN: Again, the simplicity and the reliability of the system has been its features and its hallmark. You have to be very careful when you add some of these back-up functions to be sure that you don't cause a more serious problem by their malfunction.

In this case, we have not considered a way to try and assure that the spoilers come up by other than the tire spin-up or the nose gear compression which are the two key things to let the auto spoiler system know that you've touched down.

MR. PEREIRA: Okay. Thank you. Would you please explain the MD-80 spoiler knock-down feature, whereby advancing the throttle lever causes them to stow? I believe you showed it in the short video that you showed there.

MR. GILLERAN: Yes. We could -- let's go back to Page Number 9, please. There's a good diagram of that. There is a call-out on that slide for the left throttle knock-down cam. There it is right there.

There is a mechanical connection between the left throttle and the left throttle knock-down cam, such that when the left throttle is advanced approximately one and a quarter inches, I believe, that cam will cause the spoiler handle to knock down.

Now, that could be done -- that will not happen when you're in the armed position here, but if I can see the other slide now, go to the -- when you have deployed the spoilers, the cam is still visible in the background there.

You advance the throttle. It will knock the handle off the hook, off the pin, and allow the mechanism to spring forward to the -- to the stowed position, and this is very important to assure that the airplane is capable of go-around.

The worst thing that could happen is to have the spoilers remain up when you're trying to take off.

MR. PEREIRA: Is there any way that this functionality could have prevented the ground spoilers from deploying in this accident?

MR. GILLERAN: Yes, it could. If the spoiler -- if the throttle -- left throttle was advanced approximately one and a half inches, the auto spoiler -- if I could have that slide back, please?

The auto spoiler, when it travels back, would bump into that cam and immediately snap down. So, you recall in the video how the handle came back and stopped. In that case, the handle would come back almost to the end and would snap out of position and then spring forward immediately, along with all the clanking noises that go with it, and again, this is another reason why we train for the pilot not flying to -- to observe that handle's position.

MR. PEREIRA: If this function had come into play with the spoilers in this accident, would we have had any signature of that on the FDR and the CVR?

THE WITNESS: That's a good question. We -- there was some experimental work done last week on our part on one of our MD-90 aircraft, where we attempted to cause the spoiler to be knocked down, and the answer is that we did actually catch an indication from the spoiler position sensors of approximately seven degrees as a result of that activity.

We've reviewed the data from the FDR, and we're unable to identify a signature that would be comparable.

Now, I don't believe that's fully conclusive, though. It is not solid evidence that the handle did not get knocked down by the throttle position.

MR. PEREIRA: Would there be any cockpit audio associated with the movement of the handles and the knock down and return?

MR. GILLERAN: I would -- I'm not knowledgeable how sensitive that is. Perhaps those who have listened directly to a CVR could say whether or not the activity associated with a knock down would be heard or picked up on the CVR.

MR. MELODY: Excuse me. I've never done that particular maneuver. I know that's how it works. I know that if you land with the throttles forward and the spoilers armed, they'll -- they'll deploy immediately, retract, but I've never heard that. So, I'm not sure how audible that would be on the CVR.

MR. PEREIRA: Okay. Thank you. Is there any evidence that the auto brakes were used in this accident or that the system failed in any way?

MR. GILLERAN: No, there is no evidence to show that. You have to keep in mind that the auto brakes key off the spoiler handle motion. So, auto brakes wouldn't try to apply brakes unless the spoiler handle moved, and based on the data that we see, the spoiler handle did not move.

Now, if the auto brakes had been armed, and the spoiler had knocked back down, they would have gone back into the armed position without applying brakes.

MR. PEREIRA: Thank you.

MR. GILLERAN: Again, that's done for safety purposes or for go-around purposes should the pilot decide to depart the runway.

MR. PEREIRA: Mr. Turner, you mentioned that the FAA minimum dry and wet runway length determination procedures took into account several factors to be conservative.

Do you think these factors are adequate or are there data to suggest that they're not and perhaps should be increased?

MR. TURNER: The Part 121 field length factors are -- aren't applied to dispatch. Once the airplane is in the air, situations can change, where the airplane ends up in the situation that's different than it was dispatched at.

So, we provide data in the Flight Crew Operating Manual to allow for adjustments and decisions to be made whether a landing field length, say, remains suitable. For example, the cases with ice and some of the contaminated depths may exceed the FAA factor field length requirement.

MR. PEREIRA: Okay. The stopping distance data you presented shows the ground spoiler deployment, auto brake use, appropriate elevator inputs, touch down speed, and low runway friction all have significant effects on the MD-80 stopping distance.

How does the MD-80 AFM and FCOM convey these facts to operators, and should there be additional information or procedures in them in light of this accident?

MR. TURNER: The -- the chart that we showed you about the surface condition and reverse thrust has some information there. I -- I don't think anybody would intentionally plan on landing without using the spoilers. That was an unforeseen event.

So, I'm not sure what information you could present that would be useful.

MR. PEREIRA: I can't exactly recall those charts. Did they show landing distance data for VREP plus 20? Can you dispatch without spoilers? Would that be appropriate to show those distances without spoilers?

MR. TURNER: Okay. You can dispatch without the auto spoiler feature inoperative, with, you know, a special emphasis on manually deploying the spoilers. You can, I believe, dispatch with the -- the two inboard panels inoperative with the performance penalty, where we add extra stopping distance to allow for that, but -- let's see. And there's a -- there's some other features -- let's see. It wouldn't apply to this model, but you can -- but there's no -- there's no information for the spoilers inoperative with the full landing flap.

MR. BERMAN: Mr. Turner, I think what Mr. Pereira might be looking for, or maybe this is for Captain Melody, is would it be -- would it be useful for pilots to understand the nature of the information that you presented here today?

In other words, the relatively smaller contribution of reverse thrust, and the very large contribution of -- of a spoiler deployment and the effect on the weight distribution.

MR. TURNER: Yes. The information -- actually for a normal diversion, we -- at Boeing, we use what we call an airport analysis, and we can go into the airport analysis and find out the maximum weight we can land for that runway, wet or dry.

If we have an abnormal configuration in the Volume 1 of the FCOM, we have landing data that shows landing distances for various weights, and there would be that table in there for landing without spoilers in the event of an all-hydraulic failure.

MR. GILLERAN: We should make it clear, though, there are no provisions for dispatching the airplane for revenue flight with the spoiler system inoperative. Only pieces of it, small pieces.

MR. BERMAN: But just for training purposes, not operational, don't you think it'd be important for pilots to understand, and do you think maybe they don't fully understand in general without going through the reams of data in these tables, just what the big -- what the big influencers are on stopping distances?

CHAIRMAN HALL: Well, I'd like to get clarified, too. What's on the MEL in regard to spoilers?

MR. MELODY: You can dispatch without the auto spoiler, and that requires a penalty. You have to go into the MEL and take a weight penalty for dispatching without the auto spoilers. That's to account for the time delay, the distance that you may eat up while you've now recognized the spoilers didn't fire, and you manually deploy them.

You can also dispatch with the inboard, the two inboard ground spoilers locked out, and then for the MEL condition for that, you also have to go in and take a landing distance penalty.

CHAIRMAN HALL: Okay. And what is -- what is the impact of those two not coming up? The degradation. Is that the appropriate word in performance?

MR. MELODY: The loss of lift would not be as significant for those two panels. In the DC-9, we didn't have those two panels. That portion of the wing doesn't generate as much lift as the outboard portion of the wing where there's a lot more camber.

So, in the inboard portion of the wing is -- is there. It's strengthened enough to support the weight of the wheels, and it's there to attach the outboard portion of the wing, but by itself, it doesn't generate proportionately as much lift. So, losing those panels would not be as significant as losing one or two of the outboard panels.

CHAIRMAN HALL: Very well.

MR. MELODY: They're not equal.

CHAIRMAN HALL: Go ahead. I'm sorry I stepped on Mr. Berman's question, but I was --

MR. BERMAN: I apologize for interrupting.

CHAIRMAN HALL: MEL, every time I hear those words, I like to know what's on there.

MR. BERMAN: And just once again, my question just very briefly. Isn't this important information for pilots to understand, you know, what -- what really has a big effect on stopping distance, and what has a smaller effect for training and understanding?

MR. MELODY: Yes, and the pilots do get exposed to that in training by going through the various training malfunctions when they're going through their training scenarios. They're introduced to malfunctions that could lead to a no-flap landing or a no-flap nose-slide landing or all-hydraulic failure landing, in which case most of the hydraulic components would be inoperative, and we have landing distance charts to cover those extra landing distances as a base -- as a function of weight.

CHAIRMAN HALL: How do you know that's covered in training by the major carriers?

MR. MELODY: I guess I can't really speak for them. I would prefer that they answer that question themselves, but I know in the training program that we developed, that is a certification requirement, a certification basis for the airplane. That is the training package that we give to every operator that --

CHAIRMAN HALL: And they can change that if they want to, but the FAA's got to approve it, right?

MR. MELODY: Yes, sir. Their training program is completely controlled by their POI and APM.

CHAIRMAN HALL: That's correct.

MR. PEREIRA: Mr. Turner, you mentioned that your stopping distance simulation using the accident conditions with lack of spoiler deployment and delay of brakes and elevator application indicate an end-of-runway speed similar to the FDR end-of-runway speed.

The -- the half dry friction coefficient that was used in that simulation, would that have existed if we had had hydroplaning or reverted rubber skidding?

MR. TURNER: No. I guess the first thing I'd like to say is the half dry that we've used has been an industry standard, and I guess I used the word "average" runway, and I really didn't mean that.

We've tried to pick a fairly -- you know, a poor condition that's representative of a poor friction level. The runway at Little Rock has been grooved. It's got good surface texture. It's a very, very good runway.

So, under normal -- normally, we would have expected to get, you know, higher than the level I've used in these charts. The people from -- Tom Yager from NASA has indicated that there may be some factors due to the aircraft sliding that may have degraded the braking.

Also, the calculations were based on no wind, and we have information now from the MIT Labs that, you know, that the center field -- we have some information on the center field versus time that may be helpful. So, I -- I -- I look forward to continuing to work with the Board and exploring more of these conditions.

MR. PEREIRA: Okay. Did the MD-80 crosswind certification demonstrations include landings on wet runways, flooded runways, or icy runways?

MR. TURNER: No, they did not. The requirement for -- for crosswind is that -- let's see. You would demonstrate a crosswind capability of at least 20 percent of your stalling speed for dry runway conditions.

We actually conducted tests at Casper, Wyoming, for the -- for the MD-80, and we were -- the conditions there were up -- we found conditions we could handle up to 30 knots, and that there was still capability left in the airplane, but rather than travel to another location looking for even higher winds, we decided that 30 knots would be adequate.

The following statements in the Procedures Section of the FAA-approved AFM, "the limiting crosswind value has not been determined. However, the maximum demonstrated crosswind component for take-off and landing is 30 knots reported wind at a 50-foot height. This value was demonstrated on a dry runway with all engines operating."

The following configurations -- and then the configurations note, as you go down, it was pointed out to me that the landing configuration was done with rudder power off -- well, it was done with rudder power on and off, and that the power off being the critical case, and that was to allow for systems failure and to present what we call a conservative number in the flight manual.

MR. PEREIRA: Were any of the crosswind demonstrations done without ground spoiler activation?

MR. TURNER: Not to my knowledge.

MR. PEREIRA: Okay. Do you think it would serve any useful purpose to demonstrate safe crosswind landing characteristics or techniques on low friction surfaces or without spoilers?

MR. TURNER: Well, a normal -- the procedure is that the spoiler -- auto spoilers are observed, and that if they don't deploy, then the flight crew would deploy them manually. So, the normal operation of the airplane is that either the automatic system or the flight crew will deploy the spoilers.

MR. PEREIRA: Okay. In the Abnormal Procedures Section, is there any mention if you lose your ground spoiler functionality and are forced to land without ground spoiler, if you dispatch without auto spoilers, is there any mention that a crosswind or a low surface friction environment might pose additional difficulties or technique problems during the land?

MR. TURNER: No, sir. The dispatching with the auto spoilers inop, as we previously mentioned, requires an MEL penalty. So, we already know that the runway we're going to would be adequate to account for deploying the spoilers manually.

The crew would not be aware of a malfunction in which the spoilers were not going to work. We -- we do have an alert if there's a detected failure in the auto spoiler system. There's an alert that comes up, auto spoiler, do not use.

So, in that case, we would -- we would know that we have to deploy the spoilers manually, but in a case where the spoilers have failed in some manner, which I wouldn't know but Mr. Gilleran might, that would not be obvious to the crew until they landed and tried to -- tried to deploy the spoilers. So, they would not know in advance that the spoilers were not going to work.

MR. MELODY: For the other malfunctions, though, where -- where there is a known condition, where the spoilers are not going to deploy, i.e. a loss of hydraulic failure, then there is a note to -- to divert to an airport certainly VFR and with low wind conditions.

We -- we definitely recommend landing in low crosswind conditions with abnormal flaps, slats or spoilers.

MR. PEREIRA: Thank you. Getting back to the subject of the Boeing FCOM procedure that recommends the non-flying pilot call out spoilers not deployed, you finished out the record there and stated that that was in place as far back as 1991, and you also mentioned that the operator's not required to have that in there, operators manuals, if, I guess, the FAA finds that they have an equivalent level of safety in their manual, and you also mentioned that, I believe, you, the manufacturer, would issue a letter of no technical objection. Are both those correct?

MR. MELODY: That's correct.

CHAIRMAN HALL: Why was that manual changed and changed in '91? Do any of you gentlemen know?

MR. MELODY: No, sir. In fact, we're not sure that it was changed in '91. That's just the oldest manual that we could come across in the last couple of days. It -- it's very likely that if we find an '88 manual or an '85 manual or even the original manual, it might be in there. We'll research that. I'm not sure that it was changed. It's just that we can document that it's been that way since at least 1991.

CHAIRMAN HALL: Be sure and check the library.

MR. PEREIRA: At some point in time then, I understand that the FAA would have to have found that American's leaving that procedure out of their manual would have resulted in their finding an equivalent level of safety, I guess, and also you, the manufacturer, I guess at that time Douglas, would have written a letter of no technical objection to that being left out, is that correct?

MR. MELODY: It's possible, sir. The --

CHAIRMAN HALL: Well, that's pretty important. I would appreciate it very much if Boeing could see if you could research your records and get us information on that. I'd like to see -- see if that's documented.

MR. MELODY: Yes, sir. We'll do t hat.

CHAIRMAN HALL: Okay.

MR. MELODY: I should point out, and I think perhaps I did, that's not a requirement. It's not a legal requirement for them to come to us and request a letter of no technical objection. It's normally what they do, but we'll find out if in this case they did, and what the response was, what their reason was.

CHAIRMAN HALL: Well, and I just -- this is just an observation, and I made it. It really applies more to the FAA, but it's -- you all manufacture an airplane. You put the manual out, and each airline tweaks it a little bit, and there's certainly nothing wrong with that, but it seems to me that the FAA should carry a heavy burden of proof to be sure that the procedures in place are -- are -- are -- in terms of safety are adequate to what you initially recommended, and when we find as we did in testimony here that there is nothing in place really for the POIs of the major carriers to -- to look at this in any frequency at all, and you find differences from the major carriers and something significant to the operations as this, I hope the FAA's going to -- will -- will look at that and address that issue.

MR. PEREIRA: How did the flight crew's use of thrust reverse in this accident affect the control of the airplane on the runway?

MR. MELODY: It appears from looking at the DFDR data that when the flight crew went into reverse, they went to a Level, I believe, 1.6-1.8. There were times during the roll-out when they would come out of reverse, and here again, there's nothing in our procedure that would contradict doing that because the way our -- our book is worded, on contaminated runways, it says we recommend the use of 1.3 unless in an emergency, and I wouldn't want to secondguess anybody's judgment that this was an emergency.

MR. PEREIRA: Same question during the approach and landing regarding the rudder and use of ailerons. Was it apparent to you that he was coming down in the crab procedure or the -- the recommended procedure during the approach?

MR. MELODY: My analysis would be that he was definitely attempting to come in in a side slip. The conditions would have made that a somewhat difficult task, but my estimation of the performance was that he did a very good job landing, and the subsequent use of the rudder was appropriate.

It was the recommended use of the rudder that was in that video that Captain Lewis mentioned the other day, that even though it's a difficult thing to do, and you're drifting toward the right side of the runway to put in right rudder, he was following our recommended practice to try and steer the airplane down the runway.

MR. PEREIRA: Okay. The FDR data show that there was some right drift at the time of touch down and some nose left yaw angle as well. Is that understandable under the circumstances of high and variable crosswinds? Is that not unusual?

MR. MELODY: I would think it's not unusual that the airplane, because of the crosswind, and I'm not exactly sure what the actual crosswind level was, but it would not be unusual to have the airplane weather vane being into the wind at the point of touch down because now the main gear become a pivot point, and with the wind hitting a much larger surface area behind the center of gravity than forward of the center of gravity, it would weather vane the airplane into the wind, and Captain Bushman was attempting to -- to limit that by using the rudder, the right rudder.

MR. PEREIRA: Okay. Could you make similar comment on the captain's use of the elevator as he proceeded down the runway? Is that -- there was some mention that it added to the stopping and distance. Is that a significant effect or -- and in your FCOM, it mentions don't use excessive elevator force, yet it doesn't put a quantitative value on that. Could you comment on those issues?

MR. MELODY: In the -- in the FCOM, we do mention -- now, unfortunately, this is limited to the RTO procedure, but we recommend that the column be slightly forward of neutral to make sure that we have weight on the nose wheel for positive steering, and we do comment that excessive nose down column force will result in a longer stopping distance.

But beyond that, I -- I'm afraid I couldn't give you an answer as far as how much the landing distance would have been affected by the amount of elevator input in this case.

MR. PEREIRA: Okay. Mr. Turner, I believe you mentioned, was it, a 180 to 350, is that correct?

MR. TURNER: That's correct, but I'll call your attention to one of the notes on the top of my slide, and I may not have mentioned it, is that with the spoilers not deployed, it takes about 10 degrees of aircraft nose-down elevator to get -- or a minimum weight of three percent criteria weight on the nose gear for steering.

I think in the time history, there were values approaching 15 degrees. It's, you know, very -- very -- you know, these are numbers that I can calculate in an office. It's very difficult to call something excessive.

If the captain felt he needed more force on that nose gear for steering, then I -- I think the captain yesterday, the training captain yesterday, said the first priority was to -- to -- to get directional control back.

So, as much as this performance engineering, I'd like to have him on the brakes and, you know, have as much weight as possible on the brake wheels. I realize the first priority was to keep the airplane from going immediately off the runway to the right, and that was going to happen in about nine seconds, if he didn't take aggressive action. So, yes, the stopping distance was longer.

MR. PEREIRA: Thank you, Mr. Turner. With regards to the decision not to use auto brakes, do you think that was appropriate or understandable given the conditions or American operating procedures? Could you comment on that?

MR. MELODY: The American procedure does leave that decision to the discretion of the -- of the captain, and I know that our recommendation of using auto brakes is not universally accepted throughout the airline operator community for the MD-80. It's merely our recommendation.

We have other recommendations that operators don't necessarily accept. We recommend, for example, that you always land with the auto throttles on if they're available, and various operators have, perhaps for commonality with their other -- other fleets, they have adopted the policy that if you land manually, then you should use manual throttles.

So, it's not surprising to me that, you know, we have accepted as -- as a reasonable thing to do, if it's the airline's policy to land and leave the decision to use auto brakes as a discretionary decision for the captain based on his experience.

You know, the airline pilots have a lot of exposure to weather conditions that are much more variable than we experience while we're flight testing, and, so, you know, we would not question their policy to do that.

Now, as far as the impact of not using the auto brakes, it could result in a slight delay of the application of the brakes. On the other hand, as one of our recommended practices, if the airplane gets into a skid, we recommend releasing the brakes, getting directional control, and then reapplying the brakes.

So, it's a little bit of a situation -- when you say is there any reason not to use the auto brakes, I would say that there are conditions where it might be better if you -- if you have strong crosswinds, and you suspect you might get into a skid, you're going to want to release the brakes and get directional control.

In our recommended procedure, we do recommend you use the auto brakes, but then when you read further, it says then we want the pilot to apply smooth maximum brake pedal, and, so, in effect, we're disengaging the auto brakes very shortly after landing anyway, and then we go on further to say that you can use differential braking, if necessary, to maintain control, and you cannot use differential braking if the auto brakes are engaged.

So, there would be factors to consider. In addition to that, the auto brakes are an MEL item, and, so, you know, we have to make sure that the pilots are familiar with operating the airplane both ways.

MR. PEREIRA: Thank you. Is there any point in the approach or landing that you feel the crew should have initiated a go-around?

MR. MELODY: I'm afraid I wouldn't want to try and answer that. Not being there, I have no idea the factors that were going into their decision-making.

MR. PEREIRA: Okay.

MR. MELODY: I can say this, that once they landed and deployed the reversers, our book does have a warning about attempting a go-around.

CHAIRMAN HALL: What's that warning?

MR. MELODY: I'm sorry, sir?

CHAIRMAN HALL: What's it say? Don't do it?

MR. MELODY: It says -- it's a warning which is very unusual for the book, but it says, "Warning. Do not attempt to go around once the thrust reversers have been deployed."

CHAIRMAN HALL: Okay. That's pretty clear.

MR. PEREIRA: And the basis for that is?

MR. MELODY: We had some previous events on other airplanes where pilots have attempted to go around with the spoiler -- with -- I'm sorry -- with the thrust reversers deployed, and the concern there is even if they try to come out of reverse, depending on which engine type it is, it's very unpredictable how long it will take the engines to come fully out of reverse.

There's -- there's no flighttesting done trying to stow the reversers at those high speeds, and the manufacturer won't provide any guarantees in how long it would take for the reversers to stow at those high speeds.

So, you have no idea how long you'd have to stay on the runway before you got full forward thrust, and, so, we -- we put a warning in don't try it.

MR. PEREIRA: And is this because of the dynamic pressure on the clam shells per se?

MR. MELODY: It's not just the dynamic pressure on the clam shells. It's the spool-down time. The engine has to come all the way back down to reverse idle, and, in other words, if you're -- if you reverse, and you go up to 1.3 or 1.5, when you come out of reverse, the doors can close immediately, but the engine's got to spool down to idle on schedule before it starts up again, and in fact, that's another issue with coming out of reverse too quickly. You actually go from a reverse setting to a high-power forward setting. You don't -- you don't just go to forward idle when the doors close.

MR. PEREIRA: Okay. That concludes my questions.

CHAIRMAN HALL: Okay. How much -- let's see. That's -- I think the Chairman won that bet. I'll collect later.

Mr. Feith, you and Mr. Tew, --

MR. FEITH: We're going to --

CHAIRMAN HALL: -- please don't cover any of the same ground, but please ask whatever questions you want.

MR. FEITH: I think this is probably to Captain Melody about -- just a clarification. You had talked about the ground spoilers, and actually I think it was Mr. Gilleran that talked about this, also, about the non-deployment of the ground spoilers, that you're still -- if you don't have ground spoiler deployment, but the flight spoilers deploy, you still have spoiler lift-killing properties. It's just degraded because you don't have the inboards.

We know from the FDR data that the control yoke was being turned to get the flight spoilers up to maximum of 60 degrees on one side. They weren't symmetrical. It would have been asymmetrical.

Based on that, was there any lift-killing properties when those flight spoilers went to 60 degrees when the control yoke was turned for that brief moment? Would they have experienced any kind of lift-killing property on that wing?

MR. GILLERAN: Yes, there would be some reduction in lift on that wing.

MR. FEITH: But it would have been momentary --

MR. GILLERAN: Very right.

MR. FEITH: -- and probably --

MR. GILLERAN: I believe the --

MR. FEITH: -- negligible for the effect of doing anything to assist in braking or anything else?

MR. GILLERAN: Correct. Yeah. They were only up for, I believe, about two seconds and would not have made that much difference in the braking.

MR. FEITH: And probably -- and -- and given the fact that there was probably additional lift on the other side. So, that may have created more of a problem, less of a problem? Would that have compounded?

MR. GILLERAN: I don't believe there would have been that much increase in lift compared to what was taken off the other side.

MR. FEITH: Okay. And -- and pardon me, Mr. Chairman, if it's been covered. Did you characterize the captain's use of thrust reverser as far as pulling and then coming out and then pulling back in throughout the duration of the landing?

How -- I mean in your opinion, looking at the FDR data, can you give me a characterization of what you think he was -- was doing with that thrust reverse, and given the fact that it was asymmetrical in nature, it wasn't full as far as the numbers go, symmetrically, any possible idea of what was happening there?

MR. MELODY: Well, we do -- as I mentioned in my presentation, we do recommend that if there's any perceived loss of directional control, that you go to reverse idle and forward idle, if necessary, and -- and for two reasons.

One was the side force pushing the airplane, and -- and, so, I believe it was the correct technique to come out of reverse, and without knowing exactly the sequence and timing in that, that -- that, I think, is part of the -- the trajectory that eventually brought the airplane back on -- going back to the left.

I think it was probably a combination of removing that side force which was pushing it to the right and perhaps at that point getting more traction, turning, cornering, from the tires.

So, I think it was probably a factor in keeping the airplane from going off the right side and getting it to go back. So, as far as coming in and out of reverse, that would be consistent with our recommended procedure.

As far as it being asymmetrical, I don't know that you would be able to tell just from looking at the EPR traces because the MD-80, those Pratt-Whitney engines are not fade at control. They're strictly hydro-mechanical, and the -- the relationship between reverse lever position and actual EPR is a very, very steep slope, and it's been a situation well known in the MD-80.

So, the reverse levers could be symmetric, and there could be a difference in the actual reverse 1.4 on one side, 1.8 on the other, but as I mentioned earlier, there is no directional, no -- no noticeable yawing moment, even due to that kind of EPR split.

MR. FEITH: Okay. That takes me into my last question, and that is, is there any operational history concern about asymmetrical spool-up during reverse operation on the line as far as having -- when the captain or the flying pilot pulls reverse, a natural tendency, just because of rigging or anything else of the engines coming into an asymmetrical reverse operation?

MR. MELODY: There has been a history along that line, both on take-off and on landing, and I think it was more of an educational issue, and I made an effort over the last few years to go to the various airlines that were interested to explain that our book -- our book procedure calls for 1.3 on contaminated, 1.6 on dry, and the pilots were conscientiously trying to do that, and they were running into great problems trying to match those EPRs exactly, and until we finally realized that -- that the system has such tolerance in the reverse range, that it's extremely difficult to get those two to match completely, and, so, now we're stressing the fact that even though we have recommended numbers, that it's more important to keep the airplane -- keep the -- the reverse thrusters symmetrical and accept a split in the EPR because the yawing moment due to that is not significant.

So, I don't think it was a problem with controllability of the airplane. I think it was a problem with the crew's attempting to get both engines to those exact numbers, and, so, one pilot would be heads down jockeying the reverse levers, but like I say, it's a hydro-mechanical curve. It's very, very steep, and if you're off just a half of a degree in -- in lever angle on one side, you -- you could have an EPR split of .3 or .4.

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

CHAIRMAN HALL: So, now is that important information, Captain Melody?

MR. MELODY: Yes, sir.

CHAIRMAN HALL: So, --

MR. MELODY: It's a --

CHAIRMAN HALL: -- how are you getting that to the pilot community? Is there a manual change or how do you do that?

MR. MELODY: That's in one of the --

CHAIRMAN HALL: How do you accomplish that?

MR. MELODY: In one of those other documents, sir, that I pointed out, the Operators Bulletin, all operators letter. We've -- we've covered that particular issue fairly extensively in the last three years.

CHAIRMAN HALL: And then that's the operator's responsibility to incorporate that in their training?

MR. MELODY: Yes, sir.

MR. FEITH: Thank you.

MR. TEW: Captain Meody, -- Captain Melody, if landing using manual brakes on the runway with high crosswinds, how effectively do you think a pilot can apply and maintain maximum braking?

MR. MELODY: In my personal opinion, I don't think it's that difficult. You know, assuming that you properly -- you make sure that when you start the approach, your seat is in a proper position, that you can get full rudder travel, and you're supposed to do that, of course, before you take off.

But, you know, if you can have your seat properly and the rudders positioned properly, that you can get full rudder travel, I really don't think it's that difficult to steer and apply brakes at the same time.

MR. TEW: Even when you've got like a full throw possibly handling high crosswinds?

MR. MELODY: Yes, sir.

MR. TEW: Okay. No questions.

CHAIRMAN HALL: Is that it?

MR. TEW: Yes, sir.

CHAIRMAN HALL: All right. I believe it's Allied Pilots Association's turn to go first.

MR. ZWINGLE: Thank you, Mr. Chairman.

INTERVIEW BY PARTIES TO THE HEARING

MR. ZWINGLE: A lot of material was covered obviously, and I'll try my best not -- not to ask a question that's been covered. If it has been, if you feel that you've dealt with it adequately, please so say, and we'll move on.

And the first question I have relates to an exhibit that is not on your exhibit list, but it's Exhibit 9, Page 4, and I'll be happy -- it's the Systems Group, and I'll be happy to read -- read the paragraph I'm interested in, if you wish, or you can get the exhibit.

MR. GILLERAN: Why don't you read it, please?

MR. ZWINGLE: Okay.

MR. GILLERAN: Assuming it's a short one.

MR. ZWINGLE: And the reason I am reading this is -- is -- well, let me read it first. It has to do with the spoiler system on this aircraft, November 215AA, and the factual states, "The cockpit spoiler handle was found in the full aft position. About half of the red auto spoiler arm indicator was visible, and the handle guide (nub located in the center of the arm indicator) was resting on the pedestal surface. The spoiler handle could not be pulled up or pushed down. The handle could be moved forward about an inch. However, the left throttle would also move and vice versa."

Are you familiar with this?

MR. GILLERAN: Yes, I am.

MR. ZWINGLE: Is -- is this an accurate statement, the spoiler handle was found in the full aft position?

MR. GILLERAN: That's what the document says by the people who were there at the time. I was not at the accident site.

MR. ZWINGLE: You havenevidence --

MR. HINDERBERGER: Mr. Chairman? In fairness to Mr. Gilleran, he was not part of the Systems Group, and it may be a bit of a question asking him to answer a question that was already posed and discussed in the Systems Group activity.

MR. ZWINGLE: That's fine.

CHAIRMAN HALL: All right.

MR. ZWINGLE: And for clarification, wheel rotation is not recorded on the DFDR, is that correct?

MR. GILLERAN: That's correct.

MR. ZWINGLE: Okay. And spoiler handle position is not recorded on the DFDR?

MR. GILLERAN: That is correct.

MR. ZWINGLE: If the auto spoilers were armed, and the aircraft landed on the -- on both main landing gear simultaneously, would there be any time delays -- is there any time delay built into the mechanism before spoilers deploy?

MR. GILLERAN: Only the mechanical motion associated with it. The spoilers deploy very, very quickly. I believe in less than a half second, they're well on their way.

MR. ZWINGLE: In another -- I'm referencing another exhibit that is not on your list, but it is the Boeing FCOM or McDonnell Douglas FCOM, and it's Exhibit 2II, and if I may read that to you.

It states, "If both throttles are above idle at touch down, the outboard and inboard flight spoilers may deploy and retract, and the auto brake system will disarm." Is that accurate?

MR. GILLERAN: Yes, sir.

MR. ZWINGLE: Are you familiar with an anomaly known to at least the MD-80 pilots here at this table of the spoiler handle cycling, that is, the aircraft landing with the auto spoilers armed, and upon touch down, the spoiler handles -- spoiler handle moves towards the aft position and then retracts to the stowed position without locking in a full aft and therefore deployed position? Are you aware of this anomaly?

MR. MELODY: Not without some other malfunction. That sounds like exactly what the handle would do if the throttles were advanced from idle. So, --

MR. ZWINGLE: And I should state, also -- I'm very sorry, Captain, but throttles were in the idle position.

MR. MELODY: I'm not -- that -- that has never been reported to me, but I could certainly recommend where to start looking.

CHAIRMAN HALL: Is that something that's been reported, Captain?

MR. ZWINGLE: Via the -- the pilot report, malfunction reporting system at American. What I'm alluding to is that in a survey of the pilots involved in this investigation who are here today, each of us have experienced that anomaly.

CHAIRMAN HALL: Yes, but when you have that, do you report it?

MR. ZWINGLE:Yes, sir, absolutely.

CHAIRMAN HALL: And who's that reported to?

MR. ZWINGLE: It's recorded in the maintenance log.

CHAIRMAN HALL: Okay. And does American report that to the FAA or how's that get picked up?

MR. ZWINGLE: I can't speak to that.

CHAIRMAN HALL: Lyle, could you all check into that and see what -- if you've got any -- the POI knows anything about that, if that's been reported?

MR. STREETER: We can look. We can -- I'll -- I'll ask the POI. He's here.

CHAIRMAN HALL: He's sitting there.

MR. STREETER: The other option is -- is the SDRs to see if anything's been reported.

CHAIRMAN HALL: Yes. If you all could check that out, I'd [illegible]

MR. ZWINGLE: Yes, sir.

CHAIRMAN HALL: I don't. That is a serious matter, right?

[illegible]

MR. BAKER: Mr. Chairman, we -- we have done a -- a limited look at spoiler deficiencies as indicated in our maintenance write-ups. We have looked back in two different sweeps. I think back about a year -- as far back as a year ago, we found a very limited number of write-ups, suggesting that spoilers did not deploy when armed.

In each case, we have found a mechanical fault in the system, repaired it, and signed it off. Unfortunately, we don't have all the data we'd like to have to diagnose exactly what happened from the pilot's perspective. It's usually a more mundane straightforward report of non-deployment.

So, in a maintenance sense, we don't get the benefit of the pilot's perspective of the cycling motion, but we're going to continue to look into that through both the maintenance and -- and the various systems we have to see if we can pinpoint it further.

CHAIRMAN HALL: Okay. Thank you. I'm sorry to interrupt, but --

MR. ZWINGLE: That's quite all right, and I would agree with Mr. Baker. The nature of the write-ups could range anything from a full description to -- to the spoilers -- the auto spoilers did not deploy, and that could be the end of the report.

MR. STREETER: And, Mr. Chairman? Over here.

CHAIRMAN HALL: Oh, yeah.

MR. BAKER: Again, sorry to interrupt, but I would point out that when I put my principal maintenance inspector to work doing that, he'll be contacting American. So, we could go right to the source, if you don't mind.

CHAIRMAN HALL: Fine. That's fine.

MR. CLARK: You may also want to query the other operators.

MR. STREETER: Okay. My option there is probably going to be through the SDR system. We will do that.

MR. CLARK: Right.

CHAIRMAN HALL: Thanks, Lyle.

MR. ZWINGLE: Thank you. Gentlemen, how -- how is the MEL performance penalty for dispatch with inoperative spoilers determined? Is it on the basis of mathematical modeling or flight testing?

MR. TURNER: Let's see. I think I can answer that fairly well. For the automatic ground spoiler inoperative dispatch, it was done with a very simple conservative calculation, and I guess we've used that word a few times, but if -- if there's anything that as an engineer we're not sure of, then we'll try to find a way that, if there's any possible error, we'll err on the side of safety.

So, what we did is for the automatic system inoperative, we allowed an additional time for the flight crew to deploy the spoiler, and we assumed that nothing happened during that time, except the airplane traveled, that the drag of the airplane or the brakes did not slow down the airplane.

So, we added on some distance of just the airplane free rolling for that time period, and we -- I think we went up to the highest altitude and added on the 10-knot tail wind and came up with a number, and then we divided it by six-tenths and added another 15 percent and put it in the flight manuals.

So, I believe the number for the auto ground spoiler inoperative is 540 feet penalty.

In the case of the inboard ground spoilers inoperative, we ran flight tests and ran a set of dry runway stopping performance and -- and calculated an increment based on the difference between that and our auto -- our normal all six panels spoilers working and built the -- the penalty on that.

MR. ZWINGLE: Thank you.

MR. TURNER: Hm-hmm.

MR. ZWINGLE: With reference to Exhibit 13C, Page 23, which is the effect of spoilers on landing performance, the question related to this exhibit is, was there any wind consideration in the determination of this -- of these values?

MR. TURNER: Well, all the performance numbers quoted are for no wind, either no headwind or crosswind. They are just comparative examples of -- to show the effect of these things.

MR. ZWINGLE: Okay. Thank you.

MR. TURNER: Hm-hmm.

MR. ZWINGLE: In your presentation, you -- you discussed auto spoilers, auto brakes, and in fact auto land. There was no discussion, if I'm correct, of manual braking.

MR. TURNER: Okay. Yeah. There's -- in the -- in the terminology at the time of the certification of the MD-80, manual braking meant with the antiskid inoperative. In other words, the -- there's a -- the antiskid system on the airplane was not working, and, you know, nowadays, I think manual -- there was some confusion about pilot -- so, that's why the footnote reads pilot applied antiskid braking.

So, are you referring to antiskid inoperative?

MR. ZWINGLE: No. I'm talking about just --

MR. TURNER: Okay.

MR. ZWINGLE: -- rudder pedal-actuated brakes.

MR. TURNER: Yeah. That's what the basic --

MR. ZWINGLE: We had -- we had no discussion of this in your presentation, and I wanted to be clear that --

MR. TURNER: Okay.

MR. ZWINGLE: -- manual braking is an option, that it -- that it --

MR. TURNER: Okay.

MR. ZWINGLE: -- inter-relates with auto braking.

MR. TURNER: Yeah, yeah. The pilot-actuated braking -- I'm using pilot-actuated --

MR. ZWINGLE: I understand.

MR. TURNER: -- braking rather than the word "manual" because we get confused with the antiskid inop, which I don't think we're here to talk about.

But, yeah, the basic is pilot-applied braking.

MR. ZWINGLE: Can you -- that -- that would be, I assume, a -- a system similar to other Part 25 certificated aircraft? There's redundancies, and the system is hydraulic, and that's what I'm looking for.

MR. TURNER: Oh.

MR. ZWINGLE: It's essentially the same system as the auto brakes.

MR. GILLERAN: Well, all the certification data is done with manual braking.

MR. ZWINGLE: Okay.

MR. GILLERAN: And the manual braking system is very similar to most aircraft. So, there's nothing unusual there. The auto braking is something that's actually added on top, the auto braking system on top of the manual braking system. There's a shuttle valve that allows the computer-controlled pressure to be sent to the brakes any time the pilot can apply the rudder pedal, the brake pedals, and override the auto brakes.

MR. ZWINGLE: Understood. The accident aircraft was braked using pilot-applied braking is the point I want to make.

With pilot-applied braking, is there a requirement for main wheel spin-up, main wheel rotation, before the pressure is applied to the brake pedals?

MR. GILLERAN: The way the system is set up is that the antiskid has what's called touch down protection. If the wheels are not spinning, the two inboard brakes, inboard wheels, are blocked by the antiskid system, so that pilot-applied brake pressure could not reach the two inboard wheels.

The two outboard wheels on this aircraft, if you were to apply the brakes in the air, brake pressure would reach the two outboard wheels.

MR. ZWINGLE: Thank you. On the subject of spoilers, we do -- you discussed briefly in response to a question related to automatic deployment of the spoiler system in conjunction with the actuation of the thrust reverse levers.

I noticed on the demonstration aircraft you had on the video, that that -- that aircraft seemed to be substantially more sophisticated in technologies than the aircraft that I flew at American Airlines. In other words, there was an FMC. There was digital read-outs and so forth.

Is it -- is it really beyond the realm of possibility to -- to retrofit these aircraft with an error tolerance system?

MR. GILLERAN: What kind of system, sir?

MR. ZWINGLE: Error tolerance. In other words, one that activates with the -- with the deployment of the reverse levers as other Boeing aircraft?

MR. GILLERAN: Let me answer the first question. What you saw was the MD-90 fixed-base simulator, and all of the mechanical componentry is similar, almost --

MR. ZWINGLE: Okay.

MR. GILLERAN:-- identical to the MD-80.

The second part of your question is that nothing is impossible in terms of the amount of money that may be required to make those changes.

That would bring with it a certain amount of complexity that is inherent in most of today's modern aircraft, but, yes, the spoiler system could be redesigned in such a way that it was computer-controlled and add in more of these back-up features that you're alluding to, yes.

MR. ZWINGLE: Okay. Thank you. Are you aware that because of the instrument landing system certification at Little Rock Airport, that this aircraft could not have been auto landed? It's a Category 1 runway.

MR. MELODY: No, sir, I wasn't aware of that.

MR. ZWINGLE: Thank you. In consideration of what I believe to be the fact of the deceleration rate of this aircraft of 1420 at approximately 10 knots per 1,000 feet, --

CHAIRMAN HALL: Captain, why don't you tell us, for the audience, what a Category 1 runway is, and what's the restrictions, and how it's different from other categories, just for the interested individuals here who are not familiar with the terminology?

MR. ZWINGLE: Some quick thinking on my part. Basically, the instrument landing system, which is the precision approach system used at most major airports, including Little Rock, it's a landing system that provides both lateral and vertical guidance to the runway, and at generally the lowest available weather minimum.

There are basically three categories of the instrument landing system, depending -- that's dependent upon the -- both the equipment installed at the airport, and the equipment installed in the aircraft.

The three categories. Obviously Category 1, basically a minimum visibility of -- RVR of 2,400, which is roughly half a mile, and a decision height of 200 feet above the runway surface. The decision height is that point in which the -- the pilot must have adequate visual cues to continue the descent for a landing.

So, basically looking at 200 feet above the runway, and the decision's made about a half mile out from the runway.

With greater sophistication, we move to the Category 2 approach, which is -- can be hand-flown or auto pilot coupled, including an automatic landing, but this is lower minimum. This is down to 1,800 RVR and which is less than a half mile, and a decision height of 100 feet.

I hope I get this right because I'll be back in training if I don't. Then we have the Category 3, which, in reality, can take you down to no decision height and virtually no visibility. In fact, there are degrees of Category 3 certification where there is no forward visibility required and no decision height.

So, these are three degrees of ILS technology that we incorporate in the United States and around the world.

CHAIRMAN HALL: Thank you.

MR. ZWINGLE: Yes, sir. In consideration of the -- of the approximate deceleration rate of the aircraft, of 10 knots per thousand feet of -- of roll-out, can you offer any explanation of -- of antiskid or braking anomaly that would account for this lack of deceleration?

MR. TURNER: Well, with the half dry braking, we've -- at least with one of the cases, we are matching fairly well the event history, although, granted, it has no wind.

We would have expected better braking at -- at Little Rock. It's a grooved runway. It should have been much better than this industry standard of half dry that we used. Although this morning in some of the NASA data, there was some data that presented the fact that if you are using the cornering power of the tires, it would greatly degrade the braking performance that are available out of the tires, and I -- I think we need to work with Mr. Jacke's data and perhaps the NASA model and see if that could have caused the degradation we saw from what we would -- I think Mr. Jacke even would have expected for Little Rock.

MR. GILLERAN: We have some data on that we'll bring up here in a minute. Let me add to what C.J. has said.

Probably the most important factor was the lack of vertical load on the brakes, on the tires, in terms of why the decel was not there. But the other -- other part of that again, as C.J. referred to, is the yawing of the aircraft, and if I could have that slide up, please.

Backing out the calculations in the DFDR data, we can calculate the angle of the main tires relative to the direction of motion of the aircraft. Starting at the left-hand side of touch down, the main tires were at approximately two degrees from the direction of motion, and you can see that they increased as the airplane progressed down the runway to a peak of approximately, at this point, about 15 degrees relative to the direction of motion.

At that point, most of the tire traction is trying to go out in cornering forces. The airplane then began to swivel back the other way and actually was now nose right of the direction when it departed the end of the runway. Nose right relative to the direction of travel.

So, a lot of the traction, what was available, was being used in cornering. Of course, more important was that the spoilers were not able to give the vertical load to make both the cornering force and the braking force a higher value.

MR. ZWINGLE: Thank you very much. No further questions.

CHAIRMAN HALL: Association of Professional Flight Attendants?

MS. LORD-JONES: We have no questions, sir.

CHAIRMAN HALL: If you don't mind, I have a question for you that I'd like to ask in your behalf, if that's all right.

The -- I'd like to ask the panel, and this may not be fair to you and may not be in your category, but I want to raise the issue since it's not on the agenda.

We -- the Board investigated, and we have the Number 2 person from our counterpart board in Sweden. We investigated an MD-80 crash in Sweden in 1991, and the Board made five recommendations as a result of that accident, A-92 through A-9215 -- A-9211 through A-9215, to the FAA, and to require that overhead bins remain secured in survivable accidents, that they review the bin designs for other airplanes and correct problems, that they require dynamic testing standards for overhead bins, that they require new airplanes to meet dynamic standards, and to require modifications of existing airplane bins.

Member George Black, who's a member unseen here, brought to my attention and said I should observe as he did the wreckage, and I was -- folks from the Little Rock Airport were nice enough to give me a tour of the airport, and I went by and observed the wreckage, and it's clear that a number of the overhead bins became detached during this accident, that a number of the PSUs, the passenger service units, I guess is the correct thing, the underside of the bins had -- had separated and potentially become hazards, and I know our Survival Factors and Structures folks have -- have looked at this.

Do you all know whether the Boeing Aircraft Company as part of this investigation has looked at that in any detail? If not, I'd like to ask that you do.

MR. HINDERBERGER: Certainly, we'll definitely take a look at that.

CHAIRMAN HALL: We haven't had any luck getting the Federal Aviation Administration to do their job in that area. We have another accident in which the bins have detached and come loose. The PSUs have become loose and airborne, and if you go and look at the wreckage, and if you could see if there's something that could be done about that on the manufacturer of your aircraft, I'm sure that these survivors as well as all the passengers would appreciate it.

MR. HINDERBERGER: Will do.

CHAIRMAN HALL: National Weather Service?

MR. KUESSNER: No questions, sir.

CHAIRMAN HALL: The Little Rock National Airport?

MS. SCHWARTZ: No questions, sir.

CHAIRMAN HALL: The Little Rock Fire Department?

MR. CANTRELL: No questions, sir.

CHAIRMAN HALL: The Federal Aviation Administration?

MR. STREETER: Yes, sir. A few items to clarify here, I believe, first of all, with Mr. Turner, and I don't know if -- the slide numbers on here are too small for me to read, but it's Page 22 on the exhibit that has your presentation in it.

I believe you -- you pointed out in -- in making the presentation the -- the relative small effect of thrust reverse on the stopping distance. Did I -- did I understand that correctly?

MR. TURNER: Yes. I'm struggling to find the page right now. Is it the --

MR. STREETER: Well, the --

MR. TURNER: Is it the chart? The technical data?

MR. STREETER: Yes. It's the chart on the landing -- landing performance from the MD-80.

MR. TURNER: For a 127,000 pounds?

MR. STREETER: This is -- has the 80 -- oh, I'm sorry. It -- well, I've -- either one. The issue -- you have two -- two charts on that page there, and it looks like they might be like 28 and 29 on your presentation slide numbers.

MR. TURNER: Hm-hmm.

MR. STREETER: The issue is not so much the numbers as it is I wanted to make sure I understand that point that you were making, that the thrust reverse is a relatively small component --

MR. TURNER: Yes.

MR. STREETER: -- in getting the aircraft stopped?

MR. TURNER: Yeah. For the wet runway case quoted, I guess by the time we got down to the end where things had really degraded, I -- I believe the distances, you know, with and without reverse, had probably grown to more like a thousand feet.

MR. STREETER: Well, that's -- that's the point, I think, that I want to try and clarify. Your -- your statement regarding the relative effect of thrust reverse -- am I correct in assuming that that infers aggressive braking is occurring?

MR. TURNER: Yeah. Yes.

MR. STREETER: Okay.

MR. TURNER: The more braking forces you have, then the less time and distance the reverse thrust has got to act through. Yes, that's right. MR. STREETER: Okay. So, is -- am I correct then in inferring that the other side of that issue, if there -- if there is something occurring that negates your braking effect, a contaminated runway or a problem with the braking system, that the relative impact of reverse thrust obviously increases quite a bit, is that --

MR. TURNER: Yes.

MR. STREETER: OkayAnd now on that same exhibit, let's see, it says Page 24 here. I think it's Slide 32 on your display, and this is the one where you basically looked at the accident conditions and came up with the landing distance that exceeded the runway length at Little Rock.

MR. TURNER: Yes.

MR. STREETER: This states on here that this is landing distance, and I want to make sure that I understand correctly that the -- the figures that you have here would not include that 67 percent pad that goes into runway required?

MR. TURNER: That's right. These are -- these are calculated distances with no pads. The -- the pad -- the -- the six-tenths factor or adding the 67 percent comes in in determining a minimum field length required for operation.

MR. STREETER: Okay.

MR. TURNER: That the field must be long enough to allow you to get the landing distance within 60 percent of it, okay, is the way the rule kind of reads. So, --

MR. STREETER: Understood.

MR. TURNER: But field lengths have factors in it. Distances are just adding the air portion and the ground portion.

MR. STREETER: So, then this is -- under the variables that you have restricted here, this is an accurate portrayal of what the aircraft would have been expected to do?

MR. TURNER: Yes.

MR. STREETER: Okay. And now for -- for Captain Melody, that's Page 30 on the exhibit, but I believe it's Slide 56 in your presentation, and this is the one that has Boeing's spoiler lever procedure, and then with the Chairman's indulgence, I'd -- I'd like to -- since this is an issue here, I'd like to ask the captain to look at an exhibit that's not on his list which is Exhibit 2HH.

CHAIRMAN HALL: That's fine with the Chairman, but, Captain, it's up to you whether you want to --

MR. MELODY: That's fine with me, sir.

CHAIRMAN HALL: All right.

MR. STREETER: Okay. If you could provide the captain with that. I don't expect you to be an expert on American Airlines procedures.

CHAIRMAN HALL: Let -- let me just briefly explain, and I don't guess we have to the audience that's observing the proceedings like this for the first time, each of the witnesses are given the exhibits that they're supposed to testify to so they have an opportunity to review them, and we would not, without their permission, ask them to respond to questions that they have not been given the information on.

MR. STREETER: Okay. Captain, at the top of Page 2 in that exhibit is American Airlines procedure for the spoiler lever condition.

Now, when I read these, there are -- there are differences here, but both procedures appear to me to call for someone to note the condition and to act to correct it if it's not the proper condition.

The differences appear to be in -- in the call-out in your procedure as opposed to no call-out apparent here in the American procedure, and -- and who is specified to actually deploy them manually.

My question to you is, when I look at this, these seem to accomplish the same thing. Do you see something there that is -- that appears to be dangerously missing out of -- out of the procedure, other than Boeing's -- out of American's procedures?

MR. MELODY: No, sir. This would appear to be equivalent to our procedure. However, it does appear to conflict with the procedures that were provided in a different appendix.

MR. STREETER: And which one is that, sir?

MR. MELODY: I believe it was the -- their non-expanded procedures. It was pointed out in the Ops Committee report that Captain Tew put together.

MR. STREETER: Is that in the basic2A, the basic report itself? Do you think?

MR. MELODY: It's in the Operational Factors Group Chairman's Report.

MR. STREETER: Okay.

MR. MELODY: That's the comment that initiated the discussion yesterday.

MR. STREETER: Yes, Dave?

MR. MELODY: Maybe --

MR. TEW: I don't know what he's talking about. You said equivalent. The difference would be that American did not have a similar call-out that you have in yours. They do -- they did not call out no spoilers, if there was no spoilers. They had a procedure that the captain was to extend the spoilers, but there was no required call-out. They have since gone to a no spoiler call-out similar to you.

So, it wouldn't -- I don't believe it would be equivalent.

MR. MELODY: Captain Tew, what I've been shown here now is an expanded procedures checklist, dated 12/21/98, that calls for the pilot flying to -- I don't know whether this is a call-out or -- but listed under pilot flying, it says, "spoiler lever". Under pilot not flying, it says, "check full aft".

MR. TEW: Yes, sir. According to the way American explained it to me is that the pilot flying -- the pilot not flying or the pilot flying was to check if the spoilers had extended full aft.

The captain had the responsibility to extend the spoilers full aft, but neither pilot had a requirement to call out no spoilers, as the Boeing manual says. Like I say, American has now changed their procedures or is in -- in the process of changing it to no spoiler call-out, if either pilot notices it.

MR. MELODY: Well, I found exactly what you're talking about the other day, and I saw your write-up that compared ours to American's.

MR. SWEEDLER: Oh, see if that's on Page 20, Captain, of that 2A exhibit.

MR. MELODY: Yes, sir, it is. Page 20 and 21, and the difference is for the American procedure, in their Volume 2, Normal Section, Page 75, it says, "If spoiler lever does not move back to full aft position, the captain, regardless of which pilot is flying, is making the landing, will manually deploy the spoilers", and the Boeing document says if the spoiler lever does not move aft or does not remain at aft extend, the pilot not flying calls no spoilers.

So, you're right, Captain Tew, that is the difference. The one document requires the non-flying pilot to call no spoilers. So, that would be the only difference.

MR. STREETER: Okay. But then does it appear to you that both procedures do require the pilots to check for the condition and someone to correct it?

For example, your procedure calls for the pilot not flying or the pilot flying to correct the condition?

MR. MELODY: Yeah. I can see that there is a difference in that I'm not quite sure what the American -- how they interpreted their pages. I'm not sure what the pilot's responsibility is here. It just says spoiler lever, and then under the pilot not flying, it says check full aft. So, I'd need a little more time to interpret because we do call out.

So, I think the conversation yesterday was whose responsibility is it to monitor the spoiler deployment and call it out, and, so, I think there is a difference in that in one procedure, somebody is designated as the responsible person to observe and call out. Once that step has gone past, then the two procedures are pretty similar.

MR. STREETER: Okay. Thank you, sir. That's all I have, except for Chairman Hall, to let you know that we have requested those SDRs, and assuming we all get back to Washington, hopefully we'll have them next week.

CHAIRMAN HALL: Thank you very much. I appreciate that.

The American Airlines, incorporated?

MR. BAKER: Thank you, Mr. Chairman.

Mr. Turner, in a previous answer, you referred to a similar incident that you had studied in some fashion, perhaps involving a no-wind condition. Could we know, so we can go look at it, what that incident was? I gathered it was a spoiler non-deploy situation. You briefly referenced it in one of your answers.

MR. TURNER: What I -- I think I expanded in one of my answers that all of my calculations for these pages that I have presented are for no-wind conditions. I did not refer to any previous incident.

MR. BAKER: Okay.

MR. TURNER: Okay.

MR. BAKER: Thank you.

MR. TURNER: Yes.

MR. BAKER: Captain Melody, we had quite a discussion about the degree of difficulty, if you will, of achieving a 1.3 EPR or any other explicit setting, and I think we all concluded, and we would agree, that that's not the easiest thing to do in actual operations.

So, if you assume that you can't hit that precise value very easily, have you ever done any work that suggests what the quantitative impact on -- on directional because of the interference with a rudder that exceeding it really has?

We -- we know it's -- it's not a good thing to have to happen, but is it super important or have you ever been able to quantify a value on the directional control of the airplane?

MR. MELODY: Yes, sir, we did do quite an extensive survey about four years ago. One of the operators was having some difficulty with directional control in the climate in which they were operating, and we did a lot of analytical work to try to determine the impact of asymmetrical reverse thrust because even though we recommend not using asymmetrical reverse thrust for trying to steer, we are convinced that the difference in asymmetrical reverse thrust is minor compared to the amount of directional control available through the rudder.

We have all that data. We can show the -- the absolute yaw moment with one engine in full reverse and one engine shut down. That's a -- that's a landing condition that we live with every day.

Now, where it does become an issue is in that regime where we are getting interference from the eflux that is impacting the directional control available from the rudder, and that's why we recommend in those conditions where you're most likely to need all the available rudder you can get, that we limit the directional or we limit the reverse EPR to 1.3. That minimizes the impact of the eflux and -- and will give you the maximum amount of rudder capability.

The area of concern is in the 90 to a hundred knot range where eflux has the most effect. Below that, the eflux effect is there, but the rudder effectivity is decreasing due to air speed anyway.

So, we do have that data. We can discuss that, but the point that I was trying to make as far as precisely setting 1.3, we hope that we get the message across that we're more concerned about the pilots maintaining control than trying to fine tune that, whether it's 1.4 or 1.2.

The reverse thrust effect, as Mr. Turner mentioned, is not great compared to the braking effectiveness. So, it's not really that critical. It does not create yawing moments that will increase the directional control problems.

MR. BAKER: But you would agree with my description that achieving a precise --

MR. MELODY: Absolutely.

MR. BAKER: -- 1.3 is not a very easy practical thing to do?

MR. MELODY: Absolutely, and that's an engine -- not an anomaly. It's a condition because of the hydro-mechanical control. The exact lever position from one day to the next will be different because of temperature differences, because of altitude differences.

So, at one point, we tried to put a notch or a detent that would give us exactly 1.3, and from -- from the left engine to the right engine, it was different, from Day 1 to Day 2 in the morning and in the afternoon. So, I agree with you. Certainly it's -- it's not a precise control.

MR. BAKER: Your 30-knot demonstrated crosswind limit was done on a dry runway circumstance. Can we assume that that same limit applies to wet runways or -- or do you take a reduction, if you will, or in some way modify that limit for either a wet runway or reduced visibility?

Do you have any guidance that -- in either of those situations?

MR. MELODY: The -- you're correct. The maximum crosswind -- and that's not really a limit. It was the maximum crosswind that we were able to demonstrate. It was constrained by the maximum winds we could find.

The FAA in the AFM makes a note of the fact that it is not a limit. It's merely the maximum we were able to demonstrate. Had we been able to find higher winds, we would have tried to demonstrate that, but economically, it's not feasible to delay the certification for long periods of time hoping to find those winds.

We're in a similar situation today with the Boeing 717. The maximum we've been able to find is 23 knots, but in February, we're going to go out and try and find higher, but it is all done on dry runways. There is no wet runway crosswind demonstrations, and the limits that -- that you might apply, which I know you do at each airline, I can't really comment on what kind of factors you would need to put into that.

MR. BAKER: Stopping distances are based on VREF at touch down, is that correct?

MR. MELODY: Yes, sir, that's correct.

MR. BAKER: How do you address additional stopping distance if we add crosswind corrections to the VREF speed?

MR. MELODY: I believe that stopping distance would be covered in the wet runway landing distance table. You would have to have a stopping distance. So, you would -- you would have to have a runway that met that stopping distance for the -- for the wet runway.

MR. BAKER: You indicated that you believe the -- the airplane left the runway at -- at a hundred knots. Is that a calculated value or did you do some testing to try to put all of the variables in play that we see here?

MR. TURNER: Okay. I made the comment relative -- I'm sorry. I made that comment relative to the -- the calculation in my last bar chart, and that calculation for zero wind plus the half new dry and a lot of other assumptions indicated an exit velocity of a hundred knots. That would have been the gray-shaded case, the no reverse thrust.

But that was just a build-up -- it doesn't really totally -- it doesn't attempt to totally represent the conditions at Little Rock that night. We have learned a lot from the wind data. Possibly we can put some -- some wind effects into this, if we could get some good values versus time from the MIT work.

We've seen some adjustments that -- that NASA would make for the braking coefficient. So, perhaps we could do a better job of modeling that event.

MR. BAKER: I guess what I'm trying to make sure we all understand is that that conclusion comes out of a modeling approach as opposed to an actual flight simulation.

MR. TURNER: That's correct.

MR. BAKER: Thank you. Captain Melody, would -- would -- how would you characterize the three-degree crab? Is that a lot? Not so much? Do you have any reaction to a three-degree crab?

MR. MELODY: Yes, sir. I would not consider that to be excessive in a strong crosswind. You know, the objective, as I mentioned earlier, was try to land in zero side slip, but in -- in reality, that's -- that's a difficult thing to do.

But I would think that -- that three degrees would not be a real concern to me. My concern is more when the side slip gets up above 10, 10, and then gets bigger, that's when I consider that to be losing directional control.

MR. BAKER: Would you agree that looking at the DFDR, that the aircraft touch down was actually at about three degrees?

MR. MELODY: Yes, sir.

MR. BAKER: Now, this morning, we heard a lot about reverse thrust and aerodynamics and the interface of runway friction.

Based on your presentation, it appears that if an airplane lands in a crab and reverse thrust is applied, the airplane will continue to crab, based on reverse thrust and aerodynamics. Do you agree with that statement?

MR. MELODY: No, sir. The reverse thrust by itself doesn't keep the airplane in a crab. That was one of the points I was trying to make. With symmetrical reverse thrust or anything close to symmetrical reverse thrust, there is no yawing moment produced by the reverse thrust.

There is a side force, but the side force really acts at the center of gravity. It doesn't act at the back of the airplane.

One of the slides I wanted to show but was told that it probably would be too misleading was I had the engines mounted on the nose, and if you push back on the right engine, the nose is going to go right, and if you push back on the left engine, it's going to go left.

So, it has nothing to do with the fact that the engines are actually on the tail. So, I don't believe that reverse thrust by itself keeps the airplane in a crab.

The ground reactions, especially on a dry runway, would tend to take the airplane out of the crab as well as the free-strain velocity with the directional stability.

MR. BAKER: Have you ever done any work to try to understand the independent effects of -- of brakes and -- and spoilers? In other words, if you had an MD-80 of -- of the weight we're operating at, and the spoilers were deployed, what would the MD-80's landing distance be on a runway without significant traction which is what we heard this morning?

In other words, if it -- if it had essentially no -- no traction, and therefore almost no braking, between -- that would leave you with reverse and spoilers to slow it down.

Do you have any idea how long it would take to stop the airplane?

MR. TURNER: I'm not too sure about the statement without significant traction. I don't recall NASA making that statement.

MR. BAKER: Well, that was the implied statement as to the effect of traction. Have you ever done any work that looks at that variable?

MR. TURNER: Well, we -- we've provided data in the -- the FCOM with ice that had a braking coefficient that was fairly low.

I -- I certainly wouldn't characterize the NASA opinion of the traction on that runway as not significant. I don't believe Mr. Yager did.

MR. BAKER: Well, I guess we can debate that later. Why does Boeing use manual braking instead of auto brakes to determine FAR landing distances?

MR. TURNER: The auto brakes are an option for one reason, and the second reason, Mr. Hall and I will take joy in this, the manual braking does better than the automatic system.

MR. BAKER: Thank you. Is there a landing distance or landing weight penalty associated with inoperative auto brakes?

MR. TURNER: No.

MR. BAKER: No?

MR. TURNER: No. In fact, they're optional on any landing.

MR. BAKER: What's the difference between FAA wet and "a wet runway condition" that you use in your charts for the audience's sake?

MR. TURNER: The original CAR, FAA Field Length just had the six-tenths factor, and that covered for both wet and dry conditions, and at the beginning of the jet age, the FAA felt that an additional factor was required for wet runway conditions.

So, 15 percent factor was added in addition to the six-tenths factor that was used for the prop airplanes in the previous years.

The wet runway condition we've presented is -- is a mathematical model, and it's based on industry -- on standards for wet runway braking that have been an industry standard.

Recently, we've revised the take-off rules to allow for wet runway accountability, and for some years, the JAA has required wet runway accountability for take-off and has published advisory information.

So, to help fill out the information for the U.S. operator, we provide additional data in the -- in the FCOM to show the effect of some of these conditions.

MR. BAKER: Okay. All of you have heard me in particular ask almost all of the witnesses as to whether or not they were aware of any overall look at runway overruns that was being conducted anywhere in the industry.

Are any of you at all aware of any broad study or -- or work being done to try to understand it?

MR. TURNER: I'm not aware, but I think the Boeing Company would certainly be interested in participating.

MR. GILLERAN: I think each -- each incident is viewed individually for those kind of factors. Stepping back from a statistical basis, the information would be of value, I think, to see what it shows.

MR. BAKER: One last question.

MR. GILLERAN: I don't know of a committee that's working on it particularly, though, right now.

MR. BAKER: Thank you. One lat question. Your -- your material in the three presentations were given to the parties as Exhibit 13C, and as I was trying to follow that this morning, I noticed that Slides 33 and 34 in the docket material, you -- you didn't show those.

I don't think it's terribly important, but was there some reason why those two slides were -- were not used this morning?

MR. TURNER: My voice just gave out.

MR. BAKER: Thank you. No further questions.

CHAIRMAN HALL: Thank you. And last, to clean up for your own group of folks, the Boeing Commercial Airplane Group?

MR. HINDERBERGER: Thank you, Mr. Chairman. In an effort to make sure Mr. Turner's voice doesn't give out again, I think we'll withhold any questions. Thank you.

CHAIRMAN HALL: Well, it looks like they've kept their jobs, if you're pleased with that.

I think what we'll do, if you all don't mind, is take a little break before we come up to the Board of Inquiry because everybody's been here two and a half hours, and that's long enough.

So, let's take a 15-minute break.

(Whereupon, a recess was taken.)

CHAIRMAN HALL: We will reconvene the public hearing of the National Transportation Safety Board, and I'll ask Mr. Sweedler if he would -- if he has any questions.

MR. SWEEDLER: I have no questions, Mr. Chairman.

CHAIRMAN HALL: Mr. Berman?

MR. BERMAN: Just a quick point of clarification for Mr. Turner.

INTERVIEW BY BOARD OF INQUIRY

MR. BERMAN: I think you just said recently that -- that manual braking was better or more effective than auto braking. Could you explain that? That surprised me.

MR. TURNER: Yeah. We found that in the Flight Test Program, that a pilot can apply the brakes quicker than the auto brake system.

You remember the auto brake system had to wait until the spoiler handle came in before it could start ramping up the -- the brake pressure while the pilot was in a position to get the brakes immediately.

I guess I should add on to that, that the reason one would want to use the auto brake is for consistency or as a back-up. You could have the auto brakes on and land, and if you were busy with other things, then you would get -- the system would automatically apply the brakes for you. That would be the advantage.

MR. BERMAN: Okay. I understand that, and it sounds like the situation you're referring to where manual braking is -- is more effective or faster than auto braking is. It sounds like a flight test phenomenon where the pilot has his feet positioned over the pedals ready to jump on the brakes, is that right, Mr. Melody?

MR. MELODY: Oh, yes, sirWe -- when we do it, of course, we're -- we're attempting to gain the absolute best performance possible out of the airplane. There's no doubt. We practice and practice, and we have the timing down, and we know 10 knots beforehand, we're going to slam on the brakes right on the number, and that's why we have to add all those safety factors, because the numbers we get are just the best physical performance from the airplane, and we know that there will be delays in an -- I don't want to say in a normal RTO, but if an RTO ever occurs, there will probably be some hesitation and delay.

So, that's -- that's why we add three seconds and then add the safety factor.

MR. BERMAN: Thank you, gentlemen. No more questions.

CHAIRMAN HALL: Mr. Haueter?

MR. HAUETER: No questions.

CHAIRMAN HALL: Mr. Clark?

MR. CLARK: Just one area. There was a reference earlier about the runway performance calculations and modeling and simulation.

Mr. Turner, does your model incorporate the flight test data?

MR. TURNER: Yes, it does.

MR. CLARK: And the -- do simulators normally incorporate all of the factors that you incorporate into your model?

MR. TURNER: Yes, they do.

MR. CLARK: So, if I were to use a simulator, I should end up getting the same numbers you get in your modeling?

MR. TURNER: You would get essentially the same mathematical number. The advantage of a simulator would be if you wanted to put a pilot in control of it and see the control inputs.

MR. CLARK: That's in a motion-based --

MR. TURNER: Say a motion-based simulator, but by controlling the modeling process myself, my own calculations, I know what assumptions are based -- are built into it, and it's under my control, you know, what equations we're using. So, --

MR. CLARK: Those are the equations in your model versus equations somebody may introduce into a simulator --

MR. TURNER: That's correct, yes.

MR. CLARK: -- of factors that you have no control over?

MR. TURNER: Right. I just don't have ownership of them, and I'm, you know, not sure what's there.

MR. CLARK: So, when you use your model, you know what your -- all of the appropriate factors are in, at least from your estimate?

MR. TURNER: Yeah. That's correct.

MR. CLARK: Yeah. Okay. Thank you.

CHAIRMAN HALL: Very well. I see the Allied Pilots -- Captain, you had a question?

MR. ZWINGLE: Yes, sir, Mr. Chairman. If I may ask a clarification, we learned something during the break in private conversation, and I'd like to clarify it for the record.

CHAIRMAN HALL: Sure.

INTERVIEW BY PARTIES TO THE HEARING

MR. ZWINGLE: The question I asked was a situation on the MD-80 whereby a landing was being made with the auto brakes off, therefore manual or pilot-applied braking, and in a case in which there was no wheel spin-up, would brake pressure be applied to the wheels, and the answer, I believe, I received was that the -- the inboards would be locked out, but the outboards would -- would be -- experience braking.

Was there a clarification that you can add to that?

MR. GILLERAN: No. I think what you just said is correct. There is touch down protection provided by the antiskid system which would prevent the pilot-applied pressure from reaching the inboard wheels.

Pilot-applied pressure could reach the outboard wheels prior to touch down if the rudder pedal -- the brake pedals were applied.

MR. ZWINGLE: And just one more. Did -- does a pilot of an MD-80 aircraft have sufficient -- let me rephrase that.

In the case of what you understand to be the circumstances surrounding 1420, did the pilot have sufficient capability to influence the directional control of the aircraft aerodynamically with no traction from the brakes -- from the wheels?

MR. GILLERAN: That last part again, please.

MR. ZWINGLE: Certainly. Did the pilot of 1420 have sufficient capability to influence, if not maintain, directional control of the aircraft solely by means of aerodynamic resources? In other words, with zero tire traction?

MR. MELODY: I'm not completely familiar with what contribution the cornering force would have been needed. In other words, how much cornering force you would have needed from the wheels themselves with some contact on the runway.

The only other two factors then that really come into play for directional control, not for side travel but for directional control, would be the amount of rudder available versus the amount of side slip due to beta which would have been generated by the crosswind.

So, it's the same situation you get into, for example, sometimes on take-off roll, when you first release the brakes, and you have a 15 or 20 knot crosswind, you know. You usually have to put in all the rudder to -- to keep the airplane going straight, and then you start backing it out.

In this case, and I'm only guessing, I would say at a 150 knots, with whatever wind there was, and I don't want to speculate on what the wind was, but I would think that you could keep the noise going straight in this case with right rudder. It might not take all right rudder because if you think about it, if he was airborne, you know, if the assumption is that there's no traction, that's the same as being airborne.

So, you know, he -- it's just a question of whether he can maintain his track with rudder, and I think the answer would be yes.

MR. ZWINGLE: Thank you very much, gentlemen.

CHAIRMAN HALL: Very well. I really think the panel's covered everything very well. I do just have -- this is more curious, and, Captain Melody, I am not a pilot, but I have had occasion because of this position to be in numerous simulators, but you are -- you can -- you are trained to be able to move that rudder and apply full braking at the same time?

MR. MELODY: Well, I will admit, sir, that I've probably been in situations to experience that and to know exactly -- it's a developed skill.

CHAIRMAN HALL: Okay. Good. Well, we appreciate this panel very much. I think you've made an excellent contribution, and I would offer to you all the opportunity, if there's any areas that you haven't covered or things you think the Board that would care to consider, I'd be glad to give you an opportunity individually here to do that.

Mr. Gilleran?

MR. GILLERAN: Yes, Mr. Chairman. I think one of the items that Mr. Yager brought up this morning is of special interest to me. When the laws of physics have been, you know, pushed to their limits here, and our airplane is faced with going off the end of the runway, a means of arrestment to slow that aircraft down would be of the last resort, and I think that there is some work going on in this area.

I think it should be encouraged. I think it's an opportunity that will help save an aircraft in a situation like this.

CHAIRMAN HALL: Thank you, sir. Mr. Melody?

MR. MELODY: Yes, sir. I anticipated being asked this question. So, I have written down something, and I would like to read it because it's fairly important. I don't want to take a chance on missing anything.

CHAIRMAN HALL: Sure.

MR. MELODY: As a pilot and a frequent member of the traveling public, I want to thank you for the opportunity to participate in this important process. I would like to reiterate the comments made by several other witnesses.

Air safety is a team effort. Providing safe travel is our Number 1 goal. We are all in this together. The manufacturer has the responsibility for developing and certifying a safe design. The operator has the responsibility of developing and maintaining safe operating conditions. The regulatory agencies have the responsibility of developing processes and procedures for ensuring a safe aviation environment.

As Mr. Baker mentioned yesterday, we are not a hundred percent safe yet, but I believe this is the process that will get us there.

Finally, I would like to thank you and the NTSB for providing the opportunity for us to participate in this process so we can discover better ways for us to work together to improve safety.

CHAIRMAN HALL: Thank you for your comments, Mr.

Melody. Mr. Turner?

MR. TURNER: I'd likeotthank you for the opportunity of being here. I've learned an awful lot. We've received some important information from MIT and NASA, and Boeing will continue to work with the NTSB experts and try to understand what happened, and we'll do our best to do what we can to provide better information for flight crews.

CHAIRMAN HALL: Thank you very much, and this panel is excused.

(Whereupon, the panel was excused.)

CHAIRMAN HALL: The witness list, we were next supposed to hear from Dr. David Dinges, who is Director of the Unit for Experimental Psychiatry at the University of Pennsylvania School of Medicine.

Mr. Dinges is a worldwide-known researcher and was here -- was going to testify on the effects of fatigue on human performance, and also on the counter-measures that can be trained for to counteract fatigue.

Because of the weather, Dr. Dinges was unable to -- to join us. However, this issue area is one very important to the Board and one that obviously will continue to be part of this investigation.

We now have -- we have left -- and let me just go over for our audience and -- and those that are going to be able to stay with us to the end, and I hope that's as many people as possible.

Mr. -- we've got the next two witnesses that are going to be introduced. We later will have Mr. Robert Cook, who is the Engineer Systems Company, who is with -- going to discuss this runway overrun technology.

Mr. Tyner, who's the District Chief of the Little Rock Fire Department. Obviously there are a number of issues that we want public testimony on regarding the -- the actions taken immediately after the accident, and one of the passengers, Stephanie Manus, is going to talk about her experience with the child restraint system and her -- her child, who were both passengers on this aircraft.

I'll ask now, Mr. Berman, if he and -- it's going to take us some time. I probably made an error that I apologize for in not continuing this hearing into Saturday. I thought we would move a little more rapidly than we did based on the advice I received from my staff, and -- but since I am the Chairman, I will assume responsibility, and -- but we will have to continue this evening until -- until we finish, and we'll make a decision as we get later in the evening whether we want to take a dinner break or try to -- try to finish up.

So, -- but we will at this time now have the next panel. Mr. Berman?

MR. BERMAN: I call Mr. Ben Castellano and Mr. Gary Skillicorn.

Whereupon,

BEN CASTELLANO

having been first duly affirmed, was called as a witness herein and was examined and testified as follows:

Whereupon,

GARY SKILLICORN

having been first duly affirmed, was called as a witness herein and was examined and testified as follows:

INTERVIEW BY BOARD OF INQUIRY

MR. BERMAN: Mr. Castellano, let me start with you, if you don't mind. Please state your full name and business address for the record.

MR. CASTELLANO: My name is Benedict D. Castellano. My work address is 800 Independence Avenue, SW, Washington, D.C.

MR. BERMAN: Thank you. And by whom are you employed?

MR. CASTELLANO: I work for the Federal Aviation Administration.

MR. BERMAN: What's your present position, sir?

MR. CASTELLANO: I'm Manager of the Airport Safety and Certification Branch in the Office of Airport Safety and Standards.

MR. BERMAN: How long have you been in that position?

MR. CASTELLANO: I've been in this position for 10 years.

MR. BERMAN: Tell us your duties and responsibilities, please, as the manager of the branch.

MR. CASTELLANO: Okay. My office is responsible basically for all national policy and guidance on all aspects of the Airport Certification Program, commonly known as Part 139.

We're responsible for writing the regulations, and we're also heavily involved with training programs for aircraft rescue and fire-fighters.

We work closely with our Technical Center for Research and Development in different types of aircraft rescue and fire-fighting equipment as well as other equipment.

We also put out advisory circulars dealing with signing, marking, lighting, anything basically that deals with operations on an airport.

MR. BERMAN: Thank you. And what's the education and training and experience that you've had to qualify you for this position?

MR. CASTELLANO: I have a Master's Degree in Business Administration. I have five years in the U.S. Air Force, Strategic Air Command. I've been employed with the Massachusetts Port Authority as senior operations supervisor at Mass. Port, Boston Logan, also special assistant to the airport manager at Washington National Airport, now known as Ronald Reagan Washington National Airport.

Additionally, I've been involved with the grant program while with FAA, the Airport Improvement Program as well as safety and emergency planning for several different airports.

MR. BERMAN: Do you hold any FAA airman certificates or --

MR. CASTELLANO: No, I do not.

MR. BERMAN: -- engineer certifications? Okay. Thank you. Thanks a lot, Mr. Castellano.

Now, Mr. Skillicorn, please state your name, your full name and address for the record.

MR. SKILLICORN: My name is Gary N. Skillicorn, 800

Independence Avenue, Washington, D.C.

MR. BERMAN: And by whom are you employed?

MR. SKILLICORN: Federal Aviation Administration.

MR. BERMAN: What's your present position at the FAA?

MR. SKILLICORN: Current position as Lead Systems Engineer for Navigation and Landing within the Integrated Product Team.

MR. BERMAN: And how long have you held that position?

MR. SKILLICORN: I've been in the current position since March of 1999.

MR. BERMAN: Okay. What was your previous position to that?

MR. SKILLICORN: Previous was approximately 10 years within the FAA as a program manager or product team leader that supplied products, such as RVR, approach lighting systems, navigational aids.

MR. BERMAN: Hm-hmm. And would you please tell us your duties and responsibilities in your current position?

MR. SKILLICORN: Current position is as a systems engineering lead, directing activities to develop navigational products within the FAA.

MR. BERMAN: And what education and training and prior experience have you used to qualify for your position?

MR. SKILLICORN: I have a Bachelor's of Electrical Engineering, 1969, from Ohio State University, 1985 Master's of Systems Management from the University of Southern California, and I spent 20 years for the Department of Defense, the Navy Department, developing navigational aids and landing systems.

MR. BERMAN: Thank you. And do you hold any FAA airman certificates?

MR. SKILLICORN: Yes, I do. I -- I have a private pilot's certificate with instrument rating.

MR. BERMAN: And how much flying time do you have, sir?

MR. SKILLICORN: I have about 800 hours.

MR. BERMAN: Thank you very much. Mr. Feith?

CHAIRMAN HALL: I will -- just like to explain that Mr. Larry Roman, who is the Airport Crash Fire Rescue Investigator for the Board, got called last night on a highway somewhere outside of, was it, St. Louis --

MR. FEITH: Somewhere outside of Arkansas, St. Louis, somewhere.

CHAIRMAN HALL: Yes, and he had landed in the St. Louis Airport. His flight in here had been canceled. He'd rented a car to try to get here, and he was stuck in the snow. So, he is not here, and Mr. Feith is going to ask his questions. We were able to get his questions he had prepared for the next witnesses sent here, and Mr. Feith will -- will be handling those.

But I appreciate Mr. Roman's contribution to the investigation and sorry he can't be here.

INTERVIEW BY TECHNICAL PANEL

MR. FEITH: Thank you, gentlemen. I'd like to start with

Part 139 issue of frangibility on -- on the airport as far as the lighting stanchion, the approach light stanchion.

Victor, if you could put up 16D, there's a couple of pictures. I just want to use this as a graphic illustration to show exactly what we're talking about here which is the approach light structure that was struck by the aircraft.

I believe that probably, Mr. Castellano, you're going to handle these questions?

MR. CASTELLANO: Only from the standpoint that what you see here is not in the runway safety area. So, technically speaking, with regard to Part 139, there is no requirement that the area outside of the runway safety area be non-frangible.

MR. FEITH: Okay. Well, then let me start some questions.

CHAIRMAN HALL: Well, why don't you just let me get into my question, if I could, Mr. Feith, on this one very quickly?

MR. FEITH: You're cutting into my time, though.

CHAIRMAN HALL: Okay. Well, I understanOn June 3rd, 1999, after this accident, sir, Mr. Hugh Davis, who's the head of the Chattanooga Airport, wrote a letter to Jane Garvey and copied me, stating that -- and I'll just read the letter.

"I feel compelled to write after the latest tragedy in Little Rock. It appears that the craft broke apart, and a fire started after the plane struck a non-frangible pole in the runway safety area", which you pointed out as not. We're going to discuss the safety area in more detail in a minute.

"In 1973, asimilar catastrophe was averted by literally inches when a Delta DC-9 clipped off nearly a quarter mile of approach lights while landing in Chattanooga during a thunderstorm. Inches because these lights were mounted on telephone poles. One of the landing gear actually hit the poles and sheared off.

Although these poles are a known hazard, they are still there. This is our primary Cat-2 approach. For many years, this light system has been scheduled for replacement, but the date is regularly postponed. At this time, we are not aware of a firm schedule for replacement.

I'm not sure we're not alone in this situation. What can be done, and when? You have served admirably as the Administrator. I know it's not your fault for the problem, but you can certainly be part of the solution. Sincerely, Hugh Davis."

After Mr. Davis wrote this letter, I spoke to Jane about this and asked her, said Hugh's a friend of mine, and I knew some people on this Delta DC-9 accident in Chattanooga that -- fortunately, there were no fatalities on that event, and that we -- and asked for a response.

What we got at the Chattanooga Airport was a special inspection by the FAA, and, Lyle, I would appreciate it if you would see -- that might have been a scheduled inspection, but certainly I hope that no one who writes a letter from an airport to the Administrator, that's going to -- that doesn't normally initiate an FAA look at the airport, does it?

MR. STREETER: I'll check on it for you, sir. However, I presume due to the money situation, if they were there, it was probably a scheduled inspection.

CHAIRMAN HALL: Well, I would --

MR. STREETER: I'll check that.

CHAIRMAN HALL: -- assume, and maybe that's the case, but I didn't want to get Mr. Davis or the airport in trouble because I have to fly in and out of there, and if it was closed, I'd have to -- I'd be in real trouble.

But I also want it to comply, but that's -- I'd ask this issue be brought up and introduced because of this letter, and -- and as we now know, and I went and looked at this safety area, in this situation, it could be considered by some that it was fortunate that it struck this, but since it might have ended up -- the plane might have ended up in the river.

But, Mr. Feith, if you would consider with your questions -- consider with your questioning, but that's been in my craw a little bit. So, I wanted to check that out.

MR. FEITH: Okay. Let's just start real quick with a brief description of what is frangibility when it comes to airport structures. Could you just give us a brief description of that, so that we can set the stage for the following questions.

MR. SKILLICORN: Mr. Feith, I would -- I would like to answer that, if I can. I think I'm probably the best prepared for it.

MR. FEITH: Okay. Mr. Skillicorn.

MR. SKILLICORN: I guess in answer to your question about frangibility, I would like to quote from Advisory Circular 150/5300-13, "Frangible Nav Aid, a navigational aid which retains the structural integrity and stiffness up to the designated maximum load, but on impact from a greater load breaks, distorts or yields in such a manner as to present the minimum hazard to aircraft. The term nav aid includes electrical and visual air navigational aids, lights, signs, and associated supporting equipment."

MR. FEITH: Given that, can you give us an example of something that's frangible on the airport that we might be able to relate to and the type of material that it's made out of?

MR. SKILLICORN: Certainly. Several things. In fact, anything within the runway safety area that is not fixed by function will be frangible. Examples -- and we had talked earlier in the week about runway visual range equipment.

RVR is mounted on a fiberglass, they call it a low-impact resistant, LIR structure. We have had incidents where that -- where -- where an aircraft has struck one of these, minimal damage to the aircraft. The ILS localizer here at -- at Little Rock, it was impacted by the aircraft. There was little or no damage at least as far as we would assume to the aircraft. We've had other instances.

In fact, Hartford. It was American aircraft, I believe, a couple of years ago, landed short and rolled right -- right through the ILS localizer with little damage to the aircraft. So, there are many examples that frangibility is already saving lives.

CHAIRMAN HALL: Mr. Skillicorn, does the safety area here at Little Rock meet the FAA standards?

MR. SKILLICORN: Let me -- let me turn that to Mr.

Castellano, please.

MR. CASTELLANO:It meets the standards insofar as it's to the extent possible. The regulation does allow for that.

MR. FEITH: Well, can we amplify on that? This is a --

CHAIRMAN HALL: Only in Washington could I get that answer. I guess the answer is no, but you have an exemption, right?

MR. CASTELLANO: The very firm regulations saying that every safety area will be, for example, 500 feet wide by a thousand feet long, is a virtual impossibility because of the way each and every airport has been built over the years.

CHAIRMAN HALL: Right.

MR. CASTELLANO: We will try --

CHAIRMAN HALL: But you do have a standard that you think it should be?

MR. CASTELLANO: Oh, yes. Our standards --

CHAIRMAN HALL: I'm saying here that does not meet the standard.

MR. CASTELLANO: The actual standard for this type of runway would be 500 feet by a thousand feet long, and those standards are found in that same advisory circular, 150/5300-13.

CHAIRMAN HALL: And I guess my question would be, if you had a standard safety area here, would then these poles be within that?

MR. CASTELLANO: It's our attempt to try to get a full dimensional safety area whenever possible, yes.

CHAIRMAN HALL: Would the poles that are here, that are not frangible in Little Rock, would they be within the safety area if the river wasn't there, and you had a normal safety area?

MR. CASTELLANO: No. The --

CHAIRMAN HALL: They'd still be outside?

MR. CASTELLANO: They would still be outside because of the definition of the safety area would not allow a drop of what is 25 feet or whatever, plus the riprap that's there.

MR. FEITH: Okay. Let's say the ground was level.

MR. CASTELLANO: Okay. If the ground was level at that point, it would probably be a thousand feet, if we could get the thousand feet, assuming the environmental considerations were met.

MR. FEITH: Okay.

CHAIRMAN HALL: But are there -- are there many other places, other than Chattanooga, that have -- still have these structures inside the safety area?

MR. SKILLICORN: Yes, sir. Approximately 120 airports within the country have old non- -- non-frangible structures that need to be replaced.

MR. FEITH: What is a non-frangible --

CHAIRMAN HALL: I believe we made the recommendation in '73 in that regard, and that's why -- that was the first time I'd heard, but -- how many airports there still were that had that situation.

MR. SKILLICORN: Sir, maybe I can expand on that, if I can, please, --

CHAIRMAN HALL: Sure.

MR. SKILLICORN: -- or give you a little little --

CHAIRMAN HALL: I tell you, I'm not -- not looking at you gentlemen on intention, but that light right there is -- after three days, it's beginning to get to me. So, sometimes I look at the tv so it's easier on my eyes.

MR. SKILLICORN: Back in the middle -- middle 1970s, FAA realized that there would be benefits by placing or establishing frangible structures in those areas. Also, we had the technology at that time that we could build frangible structures.

In 1977, the National Transportation Safety Board made a recommendation to the FAA to establish such a program. We did do that. It's been relatively slow in that process, but of the -- I believe like 450 sites, approximately three-fourths of those, have been replaced currently. The effort has -- has slowed down recently because of lack of resources for that.

I would also like to --

CHAIRMAN HALL: Well, I'll be glad to mention it to Chairman Wolfe and see if I can do anything on helping with the resource issue when I go up and speak to him in March.

MR. SKILLICORN: Yes, sir. If I can speak to Chattanooga as well, because I know you are interested, Chattanooga was and is still one of the projects on our list. The FAA fully recognizes the value to replace that lighting system.

I guess some good news that I would tell you, the good news is that that lighting system has been delivered by the manufacturer. It's in storage, FAA storage at Oklahoma City. That is the good news.

The bad news, we have no money to install it with.

CHAIRMAN HALL: Well, now, Mr. Skillicorn, I have enough problems without being investigated, and I certainly would -- like Senator McCain here, I was only trying to bring this to you all's attention. But I'm pleased to hear that.

MR. FEITH: Following up -- following up with that, what is the frangible structure that these new lights are going to be mounted on?

MR. SKILLICORN: It all depends to what -- let's just -- let's just take a normal -- normal airport. Within -- within the near area to the threshold, the frangible or the lights are mounted on what they call EMT, electromechanical tubing, EMT, that is built to be frangible. It will break apart very easily.

If it exceeds six feet from the six feet -- six foot to the 40 foot level, we use a fiberglass, a six-foot -- six-inch diameter fiberglass mass that extends up to 40 feet. Beyond that, and there are occasions because airports tend to be built in spots that may -- may be on cliffs in this case at -- at Little -- Little Rock, the floodplain.

So, above the 40 foot point, we do need to use what we call semi-frangible, and that is the base will be made out of steel structures. Above that is where we will support the frangible mass that actually holds the lamp in place.

CHAIRMAN HALL: Well, Mr. Skillicorn, after our experience in Guam, if you remember those oral alarms were in storage. Maybe you

-- if you would provide the Board -- and I'll ask Mr. Streeter, and we'll send a formal letter -- a list of things that are in storage that are safety items that the FAA does not have the money to get installed nationwide, and I will be glad -- I have -- I'm supposed to go up and testify to Chairman Wolfe's committee and Chairman Duncan's committee on aviation safety in March, and I'll be glad to take that list with me and bring that to Congress's attention, if the Administrator's not already done so.

MR. FEITH: Can you tell us what position Little Rock is in as far as lists? What number they are on the list?

MR. SKILLICORN: Little Rock currently meets frangible standards to the extent that it can be made frangible. There is -- there is no -- no additional work planned for the frangibility issues.

MR. FEITH: Let's talk about the light structure out there. It's mounted on steel poles that are 18 inches in diameter. I think they're sunk in the ground 25 feet, extend up, I don't know, I'm guessing 30 or 40 feet.

What part of that is frangible?

MR. SKILLICORN: The very, very top mounting where the lamps are. Let me explain. When -- when a structure has to be mounted, either in water or, I think -- a floodplain really has to be considered a water-type installation. You really have to plan for moving water, ice, debris, so that you can really not -- not make those structures frangible the way we would do it on a land-based installation.

It is an exception, if you will, to our frangibility standards.

CHAIRMAN HALL: Now, off the subject of frangibility just briefly, and I only ask these questions as they come to my mind because at my age, you might forget them.

Does a -- where you have an exception for a safety area, and you shorten the area, and there's a river or a body of water under Part 139, is there a requirement that the airport have the ability to provide water rescue?

MR. CASTELLANO: Yes, there is something in -- not -- does not say they have to. They need to arrange for or have plans for water rescue when there is a significant body of water in a particular area that is outlined or described in Part 139.

CHAIRMAN HALL Okay.

MR. FEITH: Carrying on with that, given that this is a steel pole, more or less, what was the previous material? I know that those approach lights were on some other type of pole. Was it a telephone pole or why were they changed to those big steel poles? Because I know that they have been changed.

MR. SKILLICORN: My understanding is that this -- this was the initial installation of that system, installed, I believe, in the early to mid-'90s. It was designed and installed by the airport and turned over to the FAA. The FAA had oversight during that process, though.

MR. FEITH: But that part of that light stanchion -- Victor, if we can put that photograph back up, and do you have a laser pointer up there, by chance? Carolyn, if we can -- or somebody, if we can get a laser pointer.

We see the poles. We see the cat walk. What part of that needs to be frangible? You're saying that the steel poles don't because they're in the river in the floodplain. So, at what point -- is it all of the super structure above it?

MR. SKILLICORN: The Army Corps of Engineers establishes the flood level, the 100-year flood level. Good engineering design provides for that -- for consideration of that.

My understanding is -- and from the drawings that I've seen, is at that flood stage, the water essentially laps at the -- at the bottom of the cat walk. So, in other words, all of that structure outside of the riprap -- by the way, that is why the riprap is there, because of the flooding situation.

None of that can be made frangible.

CHAIRMAN HALL: So, there could be conditions in which there would be no area?

MR. SKILLICORN: Pardon me? I didn't hear that.

CHAIRMAN HALL: Once you got past the riprap, you would be in water?

MR. SKILLICORN: Yes, there are.

MR. FEITH: How about -- given the fact of the advent of all of the new composite materials, is there something that we couldn't make those poles out of, such as a composite material, that is more frangible than those steel poles that wouldn't do as much damage as those poles did to this airplane, yet resist the -- the river movement and debris that you would typically find floating in the river?

MR. SKILLICORN: Back in 1984, there was numerous exchanges between NTSB and the FAA. The recommendation was for FAA to look at research and development to -- to see whether water-based structures could be established that would be frangible.

The FAA, through analysis and testing and working with at that time National Bureau of Standards, now it's National Institute of Standards and Technology, established that it was not feasible, technically feasible to have water -- water-mounted frangible structures.

I think it was 1996, the Board accepted that final outcome from it.

CHAIRMAN HALL: Yes, and that was a Board Recommendation 84-36, made in 1984, and the response from the FAA was October 30th of '96.

MR. FEITH: Okay. We've got five years since 1996, lots have happened into the millennium. I mean is that -- does that premise still hold true?

MR. SKILLICORN: Yes, sir, it does.

MR. FEITH: With regard to the approach lights that you said are in storage right now, --

MR. SKILLICORN: Yes.

MR. FEITH: -- what -- what is that going to replace as far as the approach light system?

MR. SKILLICORN: Well, we were -- we were talking Chattanooga there.

MR. FEITH: Oh, I'm sorry. Okay.

MR. SKILLICORN: Yeah.

MR. FEITH: Is the airport boundary fence considered frangible?

MR. SKILLICORN: Ben, you want to pick that up?

MR. CASTELLANO: I don't know. Unfortunately, I didn't have a chance to go out there because the weather gods were against me. Having left D.C. a day and a half late and getting here about midnight, I never got a chance to go out to the airport.

Normally, the fencing would not be "frangible" in the same sense.

MR. FEITH: Okay.

MR. CASTELLANO: It's usually outside the safety area.

MR. FEITH: In this regard, we have a safety area that is not your typical 1,000 feet long. It's actually about a third of that or a little better than a third.

MR. CASTELLANO: 450 feet.

MR. FEITH: It's 450 feet, and that fence sits right -- right at the edge of the cliff for the rocks that -- and I would expect that that is the edge of the safety area where that rock pile starts?

MR. CASTELLANO: Actually, the --

MR. FEITH: Could we put that picture back up?

MR. CASTELLANO: -- safety area is just about where the localizer is. I believe that about marks the edge of the safety area.

MR. FEITH: Try the other picture, Victor.

MR. CASTELLANO: Yeah. The other picture, I think, would show it.

MR. FEITH: Yeah. Can you back -- is that as far out as you can go, Victor?

MR. CASTELLANO: Oh, okay. Right up in this area, right about there. That's about 10 feet roughly, where the safety area would end, just about where the localizer is.

MR. FEITH: Okay. So, between that localizer pad and the rock pile, that's where the safety area --

MR. CASTELLANO: Right. Yeah. Right.

MR. FEITH: Okay. Because I can see the fence and the rock pile. Okay.

MR. CASTELLANO: Yes. Yeah. The fence line is down in here, I believe.

MR. FEITH: Okay.

CHAIRMAN HALL: Well, where is the safety area? It looks like the runway ends into the rocks, right?

MR. CASTELLANO: The safety area ends here. This is the end of it and goes back this way towards the runway, 450 feet.

MR. CLARK: There was a photograph earlier that had a 450 foot mark and a thousand foot mark on it that showed more of an overview.

MR. CASTELLANO: I'm sorry?

MR. CLARK: A drawing.

CHAIRMAN HALL: Yeah. There we go. Okay. I see it.

MR. CASTELLANO: From the end of the runway out to 450 feet. I'm assuming where that red line is is 450 feet.

CHAIRMAN HALL: And is there some magic to the length of this runway? 70 -- what is it? 70? 7,200 feet.

MR. CASTELLANO: Is there some magic number to it? That, I don't know. I -- I can't really address that because it really becomes a -- the length is dependent upon the type of aircraft that would be using it or expected to use that runway, and it is designed by consultants --

CHAIRMAN HALL: The Airport will get into that later.

MR. CASTELLANO: -- and the airport operator. Right.

MR. FEITH: Victor, put -- put the picture back up real quick, please. I've just got one last question on this particular subject. No. The photograph.

Was there a study done when -- when they installed this approach structure as far as the floodplain is concerned, and how often water is up to the cat walk, and how far towards the runway it comes up on a cyclical basis when they -- when they designed this system?

MR. SKILLICORN: I can't speak categorically for the airport what was done. I can tell you from the drawings that the 100-year level just is short of the cat walk. Now, again what I understand and we were told, in 1988 and '91, there were substantial flooding, that the water was up to the riprap and up to that level.

In other words, that area had been totally flooded at that time. It does occur, and I think we're -- we are observing -- 100-year floods seem to be occurring more often than 100 years.

MR. FEITH: Okay. Because my -- my question is, couldn't it be mixed use? Given the fact that we don't typically expect an airplane to be where this one actually is, but how far the water does come up if it -- if it's not but every 10 years, couldn't we make it out of material that's more frangible in that area, that isn't exposed to water on a very regular basis, versus that that is either typically under water or more -- under water periodically on a very regular basis?

MR. SKILLICORN: There, I think you're probably talking of something that might be considered disposable, something that might be damaged. I understand again that the Army Corps of Engineers is concerned about any hazards that could be created to navigation by floating debris. There was -- there was concern that was expressed from that.

Let me also mention again that these lights, they are a safety item. I'm not sure if everyone understands, but this is where the transition occurs. For a pilot under instrument conditions breaking out of that clouds, his first sight will usually be the lights. So, very, very important from a safety standpoint, and they do have to be maintained. If there's flood waters in that area, even -- even part of the year, they do have to reach it. Otherwise, the lighting system would not be of much value.

MR. FEITH: One last question. Wilkes-Barre International, their approach light system because the airport sits up on a plateau is made out of, I think, telephone poles, a crisscross of telephone poles. Is that a standard for that particular area or is that on the list to be changed? Are they going to turn those to metal poles, change them or is that -- is that a standard --

MR. SKILLICORN: I don't know about that -- yeah. I don't -- I don't know about that site specifically, but my guess is that that probably is an installation that would be changed, retrofitted with frangible structures.

We donot not consider telephone poles as frangible by any means.

MR. FEITH: They are just -- they're big sticks painted brown as far as I see them there when I fly in there. So, okay.

CHAIRMAN HALL: Now, when we get to that subject of the 100-year floods later, I'm sure the Weather Service will want to comment on why they are happening more frequently than a hundred years.

MR. FEITH: With regard to RVR, Mr. Castellano, Mr. Skillicorn, whoever's going to answer it, could you just give us a brief description? We had talked about it earlier, the last couple of days. It is a key item when it comes to this accident. The pilots were dependent upon the RVR readings.

So, could you just briefly give us a description of the RVR system, what its intended purpose is, and -- and how the system actually works here at Little Rock versus maybe an older system because this is the updated system, the older system at a different place?

MR. SKILLICORN: Certainly. What we have installed here is what we call our new generation RVR. It was installed in, I believe, August of 1996, at Little Rock.

Let me just focus on the -- on the earlier technology first and then skip back to the -- the new generation system.

Probably you've -- you have seen RVRs, the older style, that's called a transmisometer. It's mounted on two stanchions. It's a light source, a transmitter that sends a light beam to a receiver on a stanchion, and, oh, by the way, those stanchions are usually made out of angle iron and concrete and are not frangible by any means.

MR. FEITH: Well, why is that? They're on airport property.

MR. SKILLICORN: Why is that? They were installed at earlier dates prior to standards for frangibility.

MR. FEITH: Should they not be retrofitted?

THE WITNESS: Yes, they should, and the plans are to also do that. Well, the intent is -- is to replace even the older transmisometers with the new generation system.

Okay. Going -- going back to the new generation system, it's a single site; that is, it's a transmitter -- infrared transmitter source and an infrared transmitter receiver that --

CHAIRMAN HALL: You don't have a photograph with you, do you, sir?

MR. SKILLICORN: I'm afraid I don't have one.

CHAIRMAN HALL: Okay.

MR. SKILLICORN: It operates by scattering principles. If there's something within this space, and we're talking a space about a cubic -- a cubic foot perhaps, such as rain or mist or snow or anything, it will scatter light into the receiver. That -- that is the sensor source.

Coupled with inputs from an ambient light sensor with a source from a -- a runway light sensor computes the runway visual range. It's an all-digital system that is transmitted to the tower for the tower -- for the tower display as well as to the local controller, approach control as well, too.

It's a read-out, digital read-out. It -- it even -- even indicates trends upward, lower or steady state.

MR. FEITH: Is it continuously updated or is it updated every 10 seconds, 30 seconds, every minute?

MR. SKILLICORN: Okay. The display is updated or potentially updated every two seconds, but it's based on the preceding minutes averaged.

MR. FEITH: On the preceding minute?

MR. SKILLICORN: One minute average. It's updated every two seconds. So, it's a -- essentially real-time basis.

MR. FEITH: And we talked -- we hit on it a little earlier. I believe that particular instrument sits at around six feet above the ground.

MR. SKILLICORN: I think we were -- we were talking earlier about the ASOS. The RVR tries to simulate better the height of the cockpit. It's usually mounted within a 14- to 18-foot level.

MR. FEITH: And typically where is that located?

MR. SKILLICORN: It is near the ILS glide slope. In the case of 4 Right, it's 1,080 feet from the threshold and offset from the center by -- center line by 400 feet.

MR. FEITH: Can you give me the limitations of the RVR equipment as far as what may affect it from giving you an accurate reading?

MR. SKILLICORN: One of the things about RVR is you have to remember that it is only measuring that point in space. It does not measure slant range to the aircraft. It does not necessarily indicate the visibility that the controller would have to the runway. It's measuring a point in space.

MR. FEITH: Typically how close to the runway is it mounted?

MR. SKILLICORN: I believe the range is from 250 to 500 feet offset from the runway.

MR. FEITH: Is that considered close enough to the runway to -- I mean can the visibility change in that 250 to 500 feet?

MR. SKILLICORN: Certainly. There can be variations. Again, it's trying to -- trying to keep it within the safety area of the runway.

MR. ZWINGLE: Mr. Chairman, excuse me. If you wish, I do have a photograph of the device.

CHAIRMAN HALL: Yes, that would, I think, be helpful to people who are not familiar with it.

Victor, could you get that up for us? Yeah. We can try.

MR. FEITH: Are there any other mechanical limitations with this device? Is it electronically powered, and does it have -- is it on a battery back-up and things like that in the event of a power outage?

MR. SKILLICORN: It is -- it is powered by AC from the airport mains, but it also has a battery back-up associated with it for a number of hours, if the power goes down.

MR. FEITH: Is it -- is it one of the items that you would typically have a required inspection of periodically as we do with ILS systems and things like that?

MR. SKILLICORN: Yes, it does. It has a quarterly maintenance period on it.

MR. FEITH: And is that a calibration or -- how do you know when it's out of calibration or how would a controller know that he's actually getting an accurate RVR reading from that piece of equipment?

MR. SKILLICORN: It is -- it is both a calibration and a certification of that device. In this case, the last -- my understanding from looking at the records was May 17th was the last one prior to the incident. Inspection done the day after the incident, and it was certified again.

CHAIRMAN HALL: How many airports have RVRs?

MR. SKILLICORN: Sir, I am not sure of the exact number, but I think we're approximately talking 150 or more. Actually, it's -- it -- we're -- the new generation system is, I think, installed at about 150 airports.

MR. FEITH: And just one last question on this particular subject. Can you -- do you know of the liability of these RVR pieces of equipment, whether it's the old system or the new system, and which is probably more reliable or --

MR. SKILLICORN: Well, one of the things my -- my understanding again is that the maintenance for the transmisometers, they're very, very susceptible to contamination of the optics. They have to be cleaned. The lenses have to be cleaned on a regular basis. This has a quarterly preventive maintenance, and that -- that does appear to be satisfactory.

MR. FEITH: Okay. Let's -- that just raised another question. If the optics are dirty, what happens to the RVR reading and the validity of that reading? How do you know that it's dirty?

MR. SKILLICORN: The RVR, the new generation RVR, senses the contamination level and modifies the algorithm to account for that within boundaries.

MR. FEITH: So, I could theoretically have mud splashed on it, dirt splashed on it or if a bird decided to sit there and make it dirty, this thing is going to know it and compensate for it or shut down or --

MR. SKILLICORN: Well, yeah. If it exceeds the limits, it will shut itself down and identify itself to the -- to the controller that there is a problem.

MR. FEITH: And do we have any evidence that this particular RVR for Runway 4 Right on the night of the accident had any kind of problem or shut itself down?

THE WITNESS: No, no indications of that.

MR. FEITH: At any time?

MR. SKILLICORN: That is true, in my understanding.

MR. FEITH: And is the RVR data that's transmitted up to the tower recorded anywhere?

MR. SKILLICORN: Yes, there is an archiving function within the RVR data processor unit.

MR. FEITH: How -- how long does it record? What the time period?

MR. SKILLICORN: The RVR archives every minute for the first five hours. That means it will hold data, minute-by-minute data, for five hours. After five hours, for the next seven hours, it will hold every five minutes data. After the 12-hour period, it goes to an hourly for the next 15 days.

So, it is somewhat limited in the time duration for archiving.

MR. FEITH: Does that recorded record include shutdowns or -- or problems with the system or just the values that are transmitted?

MR. SKILLICORN: I believe it just reads out values. Now, I believe that the RVR -- most RVRs are also interfaced with the FAA's maintenance processor system, so that the status can be monitored at -- at any time.

MR. FEITH: If I were to go out to Little Rock right now, I could go back historically and look to see right now when that thing shut down because of whatever weather conditions or whatever maintenance problem with that RVR, and I could probably find it within the last 12 hours if there was a problem?

MR. SKILLICORN: Yes, that's right.

MR. FEITH: Okay. Switching gears now, and again this is a free-for-all question to either one of you who can best answer it, and that is, we had talked about the fact that the ARFF vehicles had responded to one end of the runway and then were in search of the aircraft, and it did take some time to find the airplane, and it was found at the opposite end.

Given the fact that we know that we had basically a torrential rain storm move through after the aircraft came to rest, and the visibilities were reduced, there are systems in place, DEVS for short, which is the enhanced vision system, could one of you explain briefly what that system is, and how it may have been useful in this particular event?

Give us a cost of what it would take to retrofit a vehicle with this type of system.

MR. CASTELLANO: Okay. The DEV System, as you say, stands for Driver Enhanced Vision System. It's a relatively new system that's been developed. We did a lot of research and development up at the Tech Center in New Jersey, and now it's a production model.

It was started or used by the military for several years, and this is a civilian adaptation of it.

The DEV System actually consists of three different components. Okay. The first one and probably the most important is what's known as the forward-looking infrared system.

The second part is a navigation system that uses GPS or differential GPS. The third part is a tracking system which is basically a repeater of the navigation system and housed in normally a dispatch center.

The most important part, as I just said, really is the forward-looking infrared because what this allows the driver of a vehicle to do is to actually see in almost zero/zero visibility, he can see ahead of him, so that if there's anybody or anything in his path as he's driving a vehicle, it will show up on the scope.

It will also depict things such as runway edge lights, fire, humans that might be wandering around out there, things of that nature.

MR. FEITH: So, it's looking for heat sources?

MR. CASTELLANO: That's right.

MR. FEITH: With this system, how far can you look ahead of the vehicle?

MR. CASTELLANO: It -- it depends on the weather conditions, for the most part. The actual specifications that we have and were put out during the R&D were very limited to about -- we said something like the forward-looking infrared should be able to spot an aircraft on fire within, I believe it was, maybe 800 or a thousand feet. I'd have to look up the actual figures.

But in reality, if there's --

MR. FEITH: All right. Let me just -- under what conditions? Is that clear air?

MR. CASTELLANO: Okay. That would be under rain or fog, right.

MR. FEITH: What -- what type of rain intensity? Heavy rain, like we had here?

MR. CASTELLANO: They don't rate the rain intensity of this. However, rain has a cooling effect. So, if you have an aircraft, let's say, that is on fire, and it's below grade, such as happened here at Little Rock, the -- the intensity of the rain would keep -- would tend to keep the plume that's rising very cool.

So, you would not necessarily see this -- the aircraft until you got much closer to it. On a dark night that's clear but no moon, you'd probably be able to see that aircraft three or four miles away.

Okay. From my own experiences having been in the equipment before and having used it, we were down at an airport way out on the far side, what we would refer to as the lower 40, and we were driving on a gravel road with a fence, chainlink fence on our left-hand side, scrub brush on our right-hand side, runway was probably a good half a mile away from us, and there was an aircraft that was taxiing out, was a 727, and we were able to take that piece of equipment and aim it towards the aircraft. We could see not only the shape of the aircraft but the engines, and, of course, the wheels were a very bright glow at that time. That was over half a mile.

MR. FEITH: How effective would that system be in the snow or in --

MR. CASTELLANO: As I say, it's still effective, but the range is not going to be as great. I'm guesstimating from what I've read on the subject and -- and have talked to different people, that they probably would have had to get to -- probably pretty close to taxiway whiskey or --

MR. FEITH: Victor, can you put the airport diagram up, please? It's the drawing. Thank you.

MR. CASTELLANO: Okay. Probably about this area right here before they would have seen the fire. Remember that this was not a major fire on the aircraft. It was -- it was a fire, but it was not a major fire in the true sense where this thing is an inferno, plus as the rain is coming down, it's keeping the plume down and cool. So, you wouldn't have seen it as far back as you might have on a lighter rain or on a night where obviously maybe light fog would be in the area.

MR. FEITH: Other than the limitation that you expressed regarding rain, snow and that kind of thing, what other limitations does a system like this have?

MR. CASTELLANO: Driver familiarity. You have to be -- use this equipment to be very, very familiar with it. However, the acceptability of this equipment is becoming quite well known worldwide here. I see that the Cadillac car has introduced a forward-looking infrared system in some of their cars now. It does the same thing that this does.

But you do have to use it. It's kind of like flying on instruments for a pilot, where you can't see anything either. You've got to drive on -- fly on those instruments. You've got to look at that scope that is in your truck and not being able to see anything outside, being able to believe what you're seeing.

MR. FEITH: Is this -- is this a reliable piece of equipment that -- let me put it another way.

Does the FAA plan to require this on any of our vehicles on the airport?

MR. CASTELLANO: Two questions there. Okay. It is reliable, and in a rewrite of an advisory circular that was published in October of '97, the forward-looking infrared system is a requirement on all trucks, 1,500 gallons or above.

MR. FEITH: Would Little Rock have been required to have those?

MR. CASTELLANO: If -- this is for new trucks. If they were to buy a new truck today, yes, it would be on there. There's no requirement for them to use it. We're hoping that they would, but it would be a requirement for the truck.

MR. FEITH: And typically what is the expense of a system like this?

MR. CASTELLANO: Forward-looking infrared is not expensive. The last figures I had heard is that the equipment itself is probably about a $10 or $12,000 piece of equipment.

MR. FEITH: Okay. One question about certification manual. Apparently from what I understand from Larry Roman, who was looking into the issue, the question he says, at the time of the accident, the Little Rock ACM or Airport Certification Manual did not include a crash grid chart. Does the FAA require that under Part 139?

MR. CASTELLANO: Rather than say yes, but, okay, the regulation actually reads that it must have a grid map or other means to -- of identifying locations and terrain features on and around the airport which are significant to emergency operations.

Okay. A grid map in my own experience is not worth very much. It's not used on a daily basis on an airport. During normal operations, communications between airport operator to his dispatcher or other people, maintenance personnel, or the control tower is done in aviation language.

The only time you would really tend to use something like that is once a year, maybe once every five years. By that time, nobody even knows where the grid map is. Nobody even bothers -- would know how to use it.

MR. FEITH: Then why is it required?

MR. CASTELLANO: Okay. It -- a grid map is good for an airport the size of Dallas-Fort Worth or the new Denver International Airport, where there are certain areas that are so large, that it makes it easier to identify, but on a smaller airport, like Washington National Airport or Little Rock, the airport is small enough that there are other ways of finding or locating an object by normal communications without going through a grid map. Most airports don't use grid maps.

MR. FEITH: Is the FAA looking to revise the standard? I mean technically, if Little Rock didn't have one, would they be in violation?

MR. CASTELLANO: If they didn't have a grid map or other means of identification, yes.

MR. FEITH: What are -- what's an acceptable mean?

MR. CASTELLANO: Most of it is -- it's basically -- would be a description in the Airport Certification Manual on what type of system that they do use, and it may be a communication system where -- which would describe, let's say, in this particular case where the accident was on 4 Right but was on the roll-out end, that when operations are in the 4 Right -- on a 4 Right runway, then reference to the FAR end of it would be "the roll-out end of 4 Right".

MR. FEITH: Are you --

MR. CASTELLANO: And they could spell that out in the ACM. We would look at it to ensure that it did do what it's supposed to do.

MR. FEITH: Did Little Rock meet that requirement?

MR. CASTELLANO: I have not really looked that closely in their ACM. I did a very brief look at it. I could not find it.

MR. FEITH: We understand that Little Rock didn't have a grid map. So, I'm curious to know what their acceptable means of complying with that is.

CHAIRMAN HALL: And are the rescue people supposed to be familiar with the airport -- you know,
-- what did you say? Aviation terminology?

MR. CASTELLANO: The aircraft rescue and fire-fighter people, yes. We prefer they use aviation technology -- terminology, and --

CHAIRMAN HALL: And is that in Part 39, part of their training, and are they -- when you run your drills, are they tested on that?

MR. CASTELLANO: There -- there's a section in it that deals with airport communications, yes.

MR. FEITH: But are they tested on knowing -- having a certain level of aviation terminology in their vocabulary?

MR. CASTELLANO: What would normally happen during an airport certification inspection, the airport certification inspector would actually take a fire-fighter or two, depending upon the size of the force, and quiz that fire-fighter on certain aspects, like where is 4 Right.

CHAIRMAN HALL: Well, that's -- that's --

MR. CASTELLANO: Where's the RVR, where's -- using that type of --

CHAIRMAN HALL: You're familiar with the details of this accident?

MR. CASTELLANO: I'm sorry?

CHAIRMAN HALL: Are you familiar with the details of this accident?

MR. CASTELLANO: Details of?

MR. FEITH: This accident.

CHAIRMAN HALL: This accident.

MR. CASTELLANO: Yes. From what -- well, from what I've read in --

CHAIRMAN HALL: Well, Mr. Castellano, I don't -- I'll take your word on the grid map, but I would suggest that you get with the airport manager as I did and drive the perimeter road of that airport, and there's a lot of territory there.

MR. CASTELLANO: Relative --

CHAIRMAN HALL: There are three runways, and there's a lot of territory there, and there ought to be some way -- we have a situation here on this particular accident where there was not a standard phraseology or communication between the fire department and the tower, and as a result, time was lost in the equipment that is there paid for by the taxpayers for the purpose of responding to events like this not getting to the accident site in a timely fashion.

So, that's something we don't need to wait for this report on. I think that's something you ought to probably sit down while you're here with the airport and the fire department people and see if you can't get that worked out.

MR. FEITH: And -- and just following on what the Chairman's point, the fire department was running the runway. They got to the end. The airplane was beyond the fence, down the rocks and out into that boundary area or area that was outside the safety area, had to drive all the way back around to go through a gate to get down there. They couldn't drive over the rock.

CHAIRMAN HALL: As it was explained to me, and we're going to hear from the fire department later, so maybe -- but it was explained to me when I went that they went to -- to this end, the approach end. Then they went to the departure end. That was when they saw the accident site, and they had to back pedal and go around to the little access road, get through a locked fence to the accident site.

MR. CASTELLANO: Had they had forward-looking infrared, --

CHAIRMAN HALL: And again, let me say for this -- you know, for the benefit of this audience, this is not an isolated case. We just had a situation in Guam where we had a loss of a life that was as a result of not a timely response, and there are other events that the Board's investigated.

It's a very important issue, as you know, and I know it's your responsibility.

MR. CASTELLANO: Yes, sir.

CHAIRMAN HALL: So, I don't have to stress that to you, but I would like to see something. Since we're all down here from Washington, it would be nice to get that one checked off before you go home.

MR. FEITH: And I'll make --

(Applause)

MR. FEITH: And I'll make a request right now that if you could -- if you could provide us the information regarding Little Rock's compliance with that 139, either the grid map or their acceptable level of compliance, we'd appreciate that information, also.

MR. CASTELLANO: So noted.

MR. FEITH: Does the FAA have a definition of end-of-the-runway? Is there some clear definition or does that -- does the end-of-the-runway stop at the pavement, 50 feet off the end of the pavement, or 500 feet off the end of the pavement as being off the end of the runway?

MR. CASTELLANO: What seems to be a very simple question is not that simple because there are things, such as displaced thresholds, relocated thresholds and whatnot, but basically a runway, unless it's designated otherwise, goes from hard surface to hard surface, concrete to the end of the concrete or asphalt, beginning of asphalt to the end of asphalt.

MR. FEITH: Does it incorporate any safety area off the end of the runway?

MR. CASTELLANO: No, no.

MR. FEITH: Very good. I have no further questions. Mr. Chairman?

CHAIRMAN HALL: The only other comment I would like to get on Mr. Castellano, is there any -- any thoughts about doing anything on ELTs on commercial aircraft, emergency response beacons that go off?

MR. CASTELLANO: I know there's been discussions about ELTs. We and the airports have not really discussed it because it was something more in the Flight Standards arena.

However,on an airport, you know, the equipment would be available for homing in or locating an aircraft if an ELT is activated.

CHAIRMAN HALL: Okay. And in -- are your responsibilities may or may -- well, I'll get to that later on. Let's go to the tables.

MR. FEITH: Let me just follow -- wait a minute.

CHAIRMAN HALL: Yes.

MR. FEITH: You brought up a good point. So, let me just follow up on that real quick.

CHAIRMAN HALL: Thank you.

MR. FEITH: It's taken you three days, but I'm glad that you're -- I had to get my shot in. It's the last day, and you cut into my time.

With regard to ELT and DEVS, is it not possible to use ELT as part of ARFF response and DEVS, you know, as a GPS link tracking to find that airplane in a more timely manner?

MR. CASTELLANO: Anything is possible in today's technology. I don't know if that has been looked at. The way to do it would be not to be using the current technology of ELTs but rather to use a differential GPS because that would definitely tie -- could be tied into the DEV System through some technology.

I don't know what's been developed, but I'm sure it probably could be pretty easily.

MR. FEITH: Has the FAA thought about sponsoring a project to do that?

MR. CASTELLANO: I can't answer that. As I say, I -- we've not been involved in it from the airport arena.

MR. FEITH: Okay. Thank you.

CHAIRMAN HALL: Was that on ELTS? George was talking to me. Is that what you asked him?

MR. FEITH: ELT and GPW -- GPS and a link to the DEV System for -- for finding the airplane, yes.

CHAIRMAN HALL: Yeah. Well, I -- and I -- I know ALPA has an interest in this. Maybe Allied Pilots does. I don't know. I do know that we -- you know, we normally don't get involved in military accidents, but at the request of the Air Force and the President, we went -- we sent a group over led by Mr. Haueter on the Ron Brown accident, and because they were unable to locate that aircraft, there were several individuals that survived the accident and died, and we don't want that to happen, I don't want that to happen, in this country, and that to me is -- seems to me something that just is -- is in the common sense category, but I'm sure we'll have more -- more to say on that later when we get to the final report and recommendations.

But as always, don't wait for us if you'd like to rush ahead with it yourself.

Let's see. To the tables. Who had first time? Did you all have the first time? Did -- the Flight Attendants went first last time, right? No.

MR. FEITH: I think it's their turn now, sir.

CHAIRMAN HALL: So, it's now the turn of the Association of Professional Flight Attendants.

MS. LORD-JONES: Yes, I do have a question.

INTERVIEW BY PARTIES TO THE HEARING

MS. LORD-JONES: I think this is for Mr. Castellano, and I'm sorry if I've just butchered your name.

I am familiar with FAR 139.315 and .317, which have addressed the minimum required agents and equipment required at index airports.

Does the FAA give any guidance in Part 139 or anywhere else on minimum ARFF manning requirements stationed at the airports using the equipment and agents required?

MR. CASTELLANO: No, we do not.

MS. LORD-JONES: Is this something that you think you should look into?

MR. CASTELLANO: It would -- it might be something that we would need to review periodically, yes.

MS. LORD-JONES: Thank you.

CHAIRMAN HALL: The -- I had a family member of a survivor approach me and again, sir, I don't know if this is in your area, and, Lyle, it may be in someone else's area, but I indicated that I -- to her, that I would publicly mention this, and that I would -- we -- we would ask the Board, if we are not already looking at this issue, which I think we have in the past, to look at it, and that is the appropriate clothing -- information on appropriate clothing for passengers.

This lady had indicated to me that their daughter had spent a considerable amount of time in the burn unit, that -- where she had had clothing on, she had not burns, where she did not have clothing, she did, that she didn't -- the family did not realize the importance of proper attire on a -- in a -- on a plane and asked if -- that -- and they were also concerned about the flight attendants and their attire, and obviously this has been a very traumatic event.

I don't know what a major fire is, but I looked at that aircraft wreckage, and it was -- it was -- it was obviously quite a bit of fire that was inside the passenger compartment itself, and, so, I would appreciate it if it's not your responsibility, Mr. Castellano, if, Mr. Lyle, you would take that on, and I know there's some things that have attempted to be done in that area, but it's something that in light of this event might ought to be looked at even more closely, and that's something the Board -- I'm going to ask Nora Marshall, who's the head of our group, to -- to look at that, and obviously if any of the other individuals that were on the aircraft have any other areas that they think we need to look at, please write me or just contact me after this meeting.

The National Weather Service is going to respond as to why you all are permitting more hundred-year floods.

MR. KUESSNER: In the interest of time, we'd prefer to have an off-line discussion on that.

CHAIRMAN HALL: Okay.

MR. KUESSNER: The Weather Service has no questions.

CHAIRMAN HALL: Okay. The Little Rock National Airport?

MS. SCHWARTZ: Mr. Chairman, I'd just like to make a couple of statements to the Board.

Both the FAA and the Army Corps of Engineers were involved in the design and the construction of the runway that we have been discussing during this hearing, and we'll be happy to supply that history to the Board.

Further, we will also supply data from the Airport Certification Manual which was approved by the FAA May 10th, 1999, that will address the Board's inquiry concerning Little Rock's compliance with the advisory circular discussed by Mr. Castellano.

CHAIRMAN HALL: Well, I appreciate that, and let me also say to you that the Board appreciates the cooperation that we have received both from the airport officials, the fire department obviously as well as the media and the local people here in Little Rock have been very helpful to all my investigators.

This is my first opportunity to come to this accident site, although I've been to this city many times, and, so, it does not surprise me, but I -- I do want to publicly thank you as well.

MS. SCHWARTZ: Thank you.

CHAIRMAN HALL: The Little Rock Fire Department?

MR. CANTRELL: No questions, sir.

CHAIRMAN HALL: Those compliments extended to you, sir, as well, and I think you will be testifying later, is that correct?

MR. CANTRELL: Thank you, sir.

CHAIRMAN HALL: Some time. Maybe today. We'll find out. Federal Aviation Administration? I'm sorry. That's right. The Boeing Commercial Airplane Group? I'm sorry, Lyle.

MR. HINDERBERGER: Yes, sir. We have one question. I'm not sure if this is for Mr. Castellano or Mr. Skillicorn.

When the damaged light stanchions at the end of the runway were replaced after the accident, were they replaced with the existing design or a new design, and if they were replaced with a new design, was that new design frangible?

MR. SKILLICORN: The replacement structure was essentially identical to that previously installed.

MR. HINDERBERGER: Identical? I mean an identical design or identical in its frangibility characteristics?

MR. SKILLICORN: Well, I would say identical, except because there was some structure that was still in place within the ground, they had to build around it, but I would -- I would have to say that it -- it has identical frangible -- frangibility characteristics as the existing design.

Once again, let me just reinforce, I'm firmly convinced that it was -- was and is installed with frangibility considered to the maximum extent that it could be done, based on the circumstances and the environment that it's operating in.

MR. HINDERBERGER: Thank you.

CHAIRMAN HALL: American Airlines?

MR. BAKER: Thank you, Mr. Chairman. We may not have the right witnesses, but I think it's important that these questions be on the record, and I think they all deserve an answer.

Earlier, Mr. Dombrowsky referred to a power outage the evening of the accident at the airport. Are either of you aware of that power outage, and do you have any knowledge as to its timing, duration, and its impact on the navigation facilities?

MR. SKILLICORN: No, sir, not -- not from my standpoint.

MR. BAKER: Are you aware of any difficulties with the LWAS facilities on June 1st?

MR. SKILLICORN: I have no familiarity with LWAS equipment.

MR. BAKER: All right. Runway 4 L, the companion runway, is a thousand foot longer with a more optimal grooving pattern, as I understand it, versus 4 R. It's our understanding that the 4 L was NOTAM closed because of the ILS not being available. Are you aware of that?

MR. SKILLICORN: I am aware that the runway was not -- not available. My understanding again is that there was construction work that was being done on that runway. I'm not -- not aware specifically of the operational relationship to that.

MR. BAKER: So, you don't know -- you don't have any of the data as to the history of that ILS or what was wrong with it or how long it was out of service, when it went out of service, when it came back?

MR. SKILLICORN: No, I do not.

MR. BAKER: It's interesting to also note apropos of our discussion about overruns that it was far more in line with the thousand by five on overrun basis.

In -- in any of your knowledge, is there anything non-routine about the funding or the ownership or the custody or the maintenance of any of the navigation aids or facilities at the Little Rock Airport? In particular, the LWAS, the RVR, or the ILS equipment.

MR. SKILLICORN: I am not -- not aware of anything unique about that.

MR. BAKER: I take it, Mr. Castellano, you do not have any knowledge either?

MR. CASTELLANO: No.

MR. BAKER: Has there been anything non-routine about the performance of any of that gear at the Little Rock Airport to your knowledge?

MR. SKILLICORN: Again, negative, to my understanding.

MR. CASTELLANO: Same.

MR. BAKER: Thank you, sir. What pre-accident testing was accomplished to ensure that the RVR or LWAS equipment was operating properly?

MR. SKILLICORN: I can only speak for the RVR that I did look at the records. A certification was performed on May 17th. This is the quarterly routine maintenance and certification. The next certification occurred on June 2nd, after the accident.

To my knowledge, there was no discrepancies associated with that.

MR. BAKER: Were those records back a number of periods? Are those records available, and did you see anything historically in the records?

MR. SKILLICORN: I did not go back much beyond that, but I'm not -- not aware of anything unique.

MR. BAKER: Is there a retention requirement?

MR. SKILLICORN: There is. I'm not sure that I can speak to that. That is our Airway Facilities Organization that does maintenance on the equipment.

MR. BAKER: I think you indicated a recertification of the RVR after the accident. Was there any other testing of any of the navigation facilities after the accident?

MR. SKILLICORN: Yes, sir. I understand, and I -- I'm -- that all of the nav aids received a rapid re-recertification, ILS, VOR, lighting associated with the runway. That's our normal -- normal process.

MR. BAKER: What -- what is your understanding relative to NOTAMs on the various navigation facilities, such as LWAS, RVR, ILS, standing water on runways, reduced runway friction, runway measurement -- friction measurements?

Are you aware that those are NOTAMable items, and, if so, who's supposed to issue them?

MR. SKILLICORN: Sir, I don't think I can -- I can speak to that.

MR. CASTELLANO: The equipment that's owned by the airport will issue the NOTAM for their own equipment. For example, if there are -- if there's ponding, snow and ice removal, some piece of their equipment that is out, that's not operating, then they will -- I shouldn't say they will issue a NOTAM. They will cause a NOTAM to be issued.

The Federal Aviation Flight Service Station actually issues the NOTAM, but the information is phoned in from the airport operator to Flight Service, who will then issue the NOTAM based upon the information that's provided them or given to them by the airport operator.

For equipment that's owned and operated by the Federal Aviation Administration, then the organization, in this case Airway Facilities, would actually issue the NOTAMs through FSS.

MR. BAKER: Have either of you reviewed the NOTAM activity on these items for the evening of the accident?

MR. SKILLICORN: No, I have not.

MR. CASTELLANO: Neither have I.

MR. BAKER: To your knowledge, in -- in any other way that has not been discussed here this afternoon relative to the overrun and so forth, are there any other waivers or exemptions that the FAA has issued on the hardware or the structure of this airport?

MR. CASTELLANO: Not that I'm aware of, no.

MR. SKILLICORN:Nor have I.

MR. BAKER: Would you have any comment as to the angle of the embankment, the so-called rock piles as it has been referred to?

It frankly strikes American Airlines that that is an extraordinarily steep bank, and we don't quite understand why it was constructed with such steepness, and it certainly could have been a factor in -- with an airplane going down the side of it.

Are either of you -- would you care to comment or is there a standard in airport construction that suggests that that is either in line or out of line with -- with what you would have expected?

MR. CASTELLANO: No, there's no standard for that in our design. However, when the runway was being built, and I believe Ms. Ledwell made reference to it, the Corps of Engineers was involved. There was a request to the Corps of Engineers that they be able to fill in some of that. The Corps of Engineers denied the permit. So, you basically ended up with what you have.

MR. BAKER: Do either of you have any knowledge as to how the tower controller at this airport would determine the runway conditions and braking action? Is there technology that is at this airport or that you're aware of that could have performed that function?

MR. CASTELLANO: There is equipment that can do that function. The tower does not determine braking action. There are two different types of braking action, one that is reported by a plane landing, who will then call the pilot -- the tower saying that in our experience, we just landed, and the -- we had good braking, fair, poor, nil, whatever the case may be.

I believe you heard Mr. Yager's testimony about friction measuring devices, and there are several of those that are available on the market that could be used to determine friction measurement.

You could always go back to the old fashion way, which is take a pick-up truck, get it up to about 40-50 miles an hour, slam on the brakes, you know, and if the dog flies off the seat, you know, and that's the way we used to do that in the olden days.

But it's kind of meaningless when you're dealing with a pick-up truck trying to correlate back to an aircraft.

MR. BAKER: Is the FAA considering requiring those devices? Not the dog flying off the seat. I mean if this technology is available, and I think we heard that it was pretty accurate and pretty reliable, not a maintenance problem, why -- I'm trying to get at why we're not slamming it in on every runway we fly on.

MR. CASTELLANO: The equipment -- the equipment, to begin with, is eligible under the Airport Improvement Program. Going beyond that, several years ago, I think it's two or three years ago, we tasked the Aviation Rulemaking Advisory Committee, commonly known as ARAC, which is an organization -- it's -- it's a -- a council that has been put together with different trade organizations and members from different alphabet groups to take a look at friction measurement, and to review the friction measurement program to see if it should be a requirement that airports will meet.

The ARAC hasfinished its work. This working group has finished its work, and it is now awaiting for an ARAC issues group meeting, so they can report their work to the full ARAC.

If the full ARAC accepts this, then they will recommend to the FAA to adopt the friction measurement for maintenance purposes or not to do it. So, until that meeting takes place, we're not really sure what will happen, but we have been looking at it.

MR. BAKER: How does the controller determine that there's ponding water on a runway and the extent of that?

MR. CASTELLANO: The controller doesn't determine that. The controller, if he has a problem, or in the normal course of their operations, a person from the airport will normally go out and look at the condition of an airport after certain activities, such as weather or an accident, extraordinary situations above and beyond the normal day-to-day occurrences, and will then report to the tower what they've seen and issue a NOTAM, if it's ponding water, if it's snow and ice, what is actually out there.

MR. BAKER: In your review of this accident, was any of that activity accomplished?

MR. CASTELLANO: No, because there was no time to do it. It's -- it's not something you just -- unless you have a person that can actually get out there, but even then, they may report that there's water on the runway, but it's up to the airline to make -- the captain to determine whether he's going to land on that runway or not.

MR. BAKER: Well, I'm having a little trouble with that because I'm trying to understand how the captain might find that out.

Okay. We'll move on. RVR on 4 Right, how many devices are there, and Number 1, were they in service to your knowledge, and Number 2, there was an RVR reported to the airplane of 1,600 feet just prior to the landing? Do you know which RVR device provided that -- that data to the controller?

MR. SKILLICORN: There are two RVR sensors associated with that runway, at the approach end of 4 Right, and then, conversely, it would be on the approach end of 22 Left or that would also be the roll-out RVR for 4 Right.

To the best of my knowledge, both of those RVRs were -- were operating properly. I do not know which RVR he was reading. I would assume it is the touch down RVR, but I'm not -- I cannot really answer that question.

MR. BAKER: Is there a way to find that out at this point?

MR. SKILLICORN: Well, I think that would -- that would have to come from the ATC community.

MR. BAKER: There are rules that suggest that under certain circumstances of change and variance between a touch down and a -- and a roll-out RVR, that the controller provide both the touch down and the roll-out.

In your review of this accident, were -- were those conditions applicable, and was that done?

MR. SKILLICORN: Once again, I think that would have to be referred to Air Traffic Control to answer.

MR. FEITH: Mr. Baker, let me just make a statement, that Scott Dunham, who did the ATC work, did pull that information, and when we did the controller interview, we found that he was providing -- well, what he told us, and what we've been able to validate thus far, is that he provided touch down RVR.

MR. SKILLICORN: In fact, Category 1 ILS approach only requires a touch down RVR.

MR. BAKER: We're having a little data problem there, I think. We need to get that sorted out and documented in the -- in the record. I'm not sure we saw that information or we wouldn't have asked the question. That's something to be clarified.

CHAIRMAN HALL: Certainly.

MR. BAKER: We think it's pretty -- pretty important piece of information.

Sir, can -- can water, large rain storm, for instance, not contaminate the RVR optics?

MR. SKILLICORN: There is a potential for that. More so in a blowing snow-type of a situation, which obviously in June was not the case.

MR. BAKER: When was the last time the optics on -- on the 4 Right RVR were cleaned? Can you tell that in the maintenance records?

MR. SKILLICORN: I believe it can be done. I cannot at this time. Again, Airway Facilities would -- would have to be approached for that.

MR. BAKER: Okay.

CHAIRMAN HALL: Do you want that information, Mr. Baker, for the record?

MR. BAKER: Well, I think it'd be interesting to look.

CHAIRMAN HALL: Yeah. Well, if you could -- Mr. -- Lyle, if you could get -- can you all furnish that information?

MR. STREETER: Yes. Well, I -- I say yes. If it's available, I can, yes.

CHAIRMAN HALL: Okay. Thank you.

MR. BAKER: You're generally familiar with the events that evening and the movement of the fire and rescue vehicles. What is your view as to why it apparently took that equipment so long to realize that the accident was off the roll-out end of the runway and then to progress to the scene? Do you have a view of that from your experience?

MR. CASTELLANO: From what I've read, they were -- they were not sure of -- if there was an aircraft incident at that time or if there was, where it was located.

The information they got -- received from the tower apparently was very sparse. The weather, as we saw in a couple of those clips, was very, very bad with almost zero/zero visibility.

The fire department, when it departed the ARFF station, was in a situation where they could not go at a maximum speed that they would normally go. The roads -- the road and the ramp was slippery. There was a lot of water.

If you turn a corner at a high speed in a truck like that because of the center of gravity, you can tip it over. So, right away, with that type of water that's on there, the contamination, the -- they had to move in a slower fashion than they would normally.

Not knowing exactly where the aircraft was last seen, the -- and was told that there was an aircraft down on 4 Right, 4 Right being 7,200 feet, they had to start somewhere. So, they assumed, rightfully or wrongfully, that it was down at the approach end of 4 Right.

Okay. When they were told or found out that it was nothing there, again not knowing what they were looking for, they had to proceed up the runway. They were what they term "in search mode" as opposed to response mode. They didn't know what they had.

Again, if you're going 50 or 60 miles an hour, and suddenly that thing looms at you, you try to put on your brakes. You can either tip it or you can actually crash into it, and I can give you a lifetime situation that happened with me, if I may divert for a second.

When I was at Boston Logan Airport, a Lufthansa 707 landed on one of the runways. It had visibility minimums to land on that runway, but as it rolled out on the far end of the runway, there was zero/zero visibility at that point.

He was able to get -- turn off the runway on to a taxiway. He then proceeded to call the tower and say -- told the tower that he had landed, but he didn't know where he was. He didn't know whether he was on one of the intermediate taxiways.

So, the tower sent me out there, and again zero/zero visibility. I had my window down. The only way I could even have a sense of where he was was by listening for his engines. I was almost underneath his wing before I saw him because of the visibility.

We waited there probably an additional 15 minutes before he could see my tail lights to be able to follow me in on to the ramp.

So, night time, very bad weather, you cannot do your normal rescue or response time without endangering yourself, and it does absolutely no good to anybody if an -- if one of the trucks turns over or hits another one of the trucks, so to put both of them out of commission. So, it's a trade-off. You can only respond so fast, given the circumstances at the time.

MR. BAKER: Would you -- would you agree with me that given the circumstances, lack of information that directed the vehicles and the large difference in -- in grade between the runway level, if you will, and the floodplain level where the airplane ended up, that forward-looking infrared would have been of limited help had this equipment been equipped with that?

MR. CASTELLANO: I think I -- I already tried to cover that, but it would have been of limited help, yes. They may have been able to see the 1,000-2,000 feet back because there was a plume since there was a fire at that time. They should have been able to pick it up on the forward-looking infrared.

MR. BAKER: Would you normally have expected the tower controller to coordinate with the fire and rescue vehicles in directing them as best his knowledge would have allowed him to?

MR. CASTELLANO: Would I normally expect that? Yes.

MR. BAKER: Are you aware of whether the controller attempted to -- to do any additional directing of the -- of the vehicles?

MR. CASTELLANO: I was not in any of the interviews. The only thing I could base my assumption on here was the records, the response, you know, and I didn't see any communications after the initial in the response that had been printed up.

MR. BAKER: Are you aware of any overall look being undertaken by -- by anyone at the FAA or elsewhere on overrun accidents in the industry in this country or elsewhere?

MR. CASTELLANO: The- -there was a study that was done in approximately 1990. We have not done one since, but we have an emphasis on runway safety areas, new policy that has been put out for our airports in the design of runways, to incorporate safety areas to the extent practical or document why they can't achieve a full safety area, and looking at various alternatives.

MR. BAKER: Thank you very much. Mr. Chairman, I must reflect a modest degree of disappointment that -- and why I wanted to get all these questions in the record.

These -- these fellows did the best they could, but at the pre-hearing conference, we expressed the -- the need to understand these facilities better than we had been able to, and we had asked for a proper witness to be able to do that.

So, I'd like my list of questions to stand for further work as we go along here because we think they're pretty important to understand all the parameters here, but these gentlemen did the best they could, and

I appreciate it.

CHAIRMAN HALL: Well, I remember your request, and I thought they were supposed to be sending us somebody that could respond on those things because I had the same request. So, --

MR. BAKER: Thank you, sir.

CHAIRMAN HALL: All right. The Allied Pilots Association?

MR. ZWINGLE: Thank you. Has any construction, reconstruction or significant expansion occurred on Runway 4 Right, 2-2 Left, after January 1st of 1988?

MR. CASTELLANO: No. The runway wasn't opened up until '91.

MR. ZWINGLE: Can you -- can you offer an explicit rationale for the reduced runway safety area?

MR. CASTELLANO: Yes, I sure can. 4 Right, 22 Left, was actually designed and started construction prior to 1988. It was built as a noise-abatement runway, and in the design of the runway, there was only a given amount of land that could be used.

Again, you couldn't go northeast because of the environmental considerations at that point and the river. You could not go southwest any further than it is because of the rising terrain that occurs southwest of the runway. I believe, if I'm not mistaken, there's also a community in that location southwest of the runway.

In order to get an instrument landing system in there, the runway had to be moved a little bit to the point that it is now. If it had been moved back further southwest, they couldn't have put in an ILS system from my understanding.

A runway safety -- the runway was also envisioned, because of noise-abatement purposes, to be a departure for 4 Right and landing on 22 Left. The study that I mentioned on safety areas that was done in 1990 has showed that if -- if there's a choice between undershooting or overshooting a runway, overshoots occur about twice as often as an undershoot.

So, since an aircraft is landing on 22 Left, then the full thousand feet was probably the smart way to go for the landing aircraft, to have that thousand feet at the southwest end of the runway.

And again the shifting of it in order to accommodate an instrument landing system and the rising terrain just about dictated that's where it would go.

MR. ZWINGLE: To maintain that runway length?

MR. CASTELLANO: Right. And again, I can't get into the runway length because that was done by the consultants and the FAA several years -- many years ago, and how they came up with the 7,200 feet, I am not really sure.

MR. ZWINGLE: The study you just referenced also contains data related to aircraft overruns and correlated to the existence of runway safety areas.

Are you familiar with that data?

MR. CASTELLANO: I'm sorry?didn't --

MR. ZWINGLE: The study that you cited, and it's -- it's contained in Advisory Circular 150/5300-13. Are you familiar with the data that -- that is cited that states that a standard 1,000-foot runway safety area will contain 90 percent of all overruns while a reduced runway safety area will contain only 65 percent of the same overruns?

MR. CASTELLANO: I don't -- that does not ring a bell to me at all. Are you sure that's in 5300-13?

MR. ZWINGLE: Yes, sir. Appendix A, Figure 8-1. Should aeronautical charts provided to airmen, airpersons, contain specific depictions of or warnings of reduced safety areas, in your opinion?

MR. CASTELLANO: I'm not sure if I could really answer that question.

MR. ZWINGLE: Thank you. I understand.

MR. CASTELLANO: I'm not sure.

MR. ZWINGLE: In order to preserve the standard runway safety area, could the runway have been designed with a displaced threshold or a declared distance adjustment to the runway?

MR. CASTELLANO: Those are alternatives that should have been considered, and I don't know that they were or weren't, but it -- the declared distance concept is something that could have been looked at.

MR. ZWINGLE: Resulting in an effectively shorter runway --

MR. CASTELLANO: In this case, it probably --

MR. ZWINGLE: -- and retaining the safety area?

MR. CASTELLANO: It probably would have resulted in a shorter runway.

MR. ZWINGLE: Are you aware that an approach light system operationally is not required for the instrument landing system?

MR. SKILLICORN: Yes, that is true. The ALS provides lower minimums.

MR. ZWINGLE: Does not -- are you aware that it does not provide a lower decision height but merely a lower visibility value?

MR. SKILLICORN: Yes, that's true.

MR. ZWINGLE: In discussion of the grid system for ARFF, would you agree that the existence and utilization of a grid system would facilitate the direction and deployment of off-airport resources?

MR. CASTELLANO: Would it have facilitated it? Not necessarily. Depending upon where they were coming from, there are other ways of doing that, by pointing out a gate that they wanted these vehicles to come to or a location, aside from a grid coordinate.

Again, there are different ways of doing it, and if there is appropriate training between mutual aid and the airport operator and other responders, normally that's usually hammered out as to where they should go to in advance, not necessarily depending upon a grid system.

It's hard to say. It may work, it may not. It would -- that's something that really would depend upon how the airport is organized, and how they interact with their mutual aid companies.

MR. ZWINGLE: I understand, and you may not be the appropriate witness to ask this question, but do you know if the off-airport resources are familiar enough with the aviation terminology and the taxiway and runway identification to -- to be effectively deployed?

MR. CASTELLANO: I think that would be an appropriate question for either the airport or the fire department because I don't know --

MR. ZWINGLE: I understand.

MR. CASTELLANO: -- the extent of the training -- their cross training.

MR. ZWINGLE: Understand. Why was the Runway 4 Right, 2-2- Left, grooved and approved for a non-standard two-inch spacing device, the one and one-half spacing called for in --

MR. CASTELLANO: I don't believe it's a non-standard. I believe that there is a -- a range. The minimum is one and a half, and the maximum is two inches.

MR. ZWINGLE: Do you know if the Little Rock Airport has a runway surface condition sensor installed on any runway?

MR. CASTELLANO: I've heard reference to it. I do not know if they have one or not.

MR. ZWINGLE: Do you know where I could find that answer?

MR. CASTELLANO: The airport. It would be an airport-owned piece of equipment. So, the airport operator should be able to answer that.

MR. ZWINGLE: Thank you. No further questions.

CHAIRMAN HALL: Mr. Sweedler?

MR. SWEEDLER: Just one comment. We had some discussion yesterday and a little earlier about the Runway 4 Left being closed, and the question was asked how long it had been closed, and I don't think you knew the answer, but I'm just asking, is it possible that we could -- we could get that information for the record?

MR. STREETER: Yes, and I have one question for my own witness, also.

CHAIRMAN HALL: Oh, I'm sorry.

MR. STREETER: No, no.

CHAIRMAN HALL: I'm sorry.

MR. STREETER: That's all right, sir. Let me -- let me take the opportunity to make a statement here.

CHAIRMAN HALL: Lyle, I'm sorry.

MR. STREETER: Okay. To deal with Mr. Sweedler's question and hopefully -- let me apologize, not being at the pre-hearing conference, we --

CHAIRMAN HALL: Mr. Donner was there.

MR. STREETER: I understand, but we misunderstood the diversity of the questions. We thought we were providing you -- let's just say that for the question list I heard tonight, I'd have to have three more people on the panel.

So, what I will do is if Mr. Baker will provide you with the question list in writing, we will provide answers to every question that we have that information available for.

CHAIRMAN HALL: Thank you.

MR. STREETER: Okay. And then the only question I have for my witness here is for Mr. Castellano. There was some testimony earlier today that indicated that -- in regards to runway contamination, that rubber removal was a recommendation rather than a requirement. Is that a fact, sir?

MR. CASTELLANO: It is a requirement under Part 139.305 that deals with paved areas. It says that mud, dirt, loose aggregate, debris, foreign object, rubber deposits and other contaminants shall be removed promptly and as completely as practical.

MR. STREETER: Okay. Thank you, sir.

MR. CASTELLANO: So, it is a requirement in 139.

MR. STREETER: All right. And -- and, Mr. Sweedler, if you'll throw your question on that list, we'll get it answered for you.

MR. SWEEDLER: Fine. I just had one other -- one other comment more than -- more than a question.

INTERVIEW BY BOARD OF INQUIRY

MR. SWEEDLER: We're talking about the safety areas at this airport, and we've talked about them in a few other airports, but a study that the FAA did in answer to one of our recommendations indicated that 58 percent of the runway safety areas in the nation meet -- meet the standards, the current standards, 25 percent do not meet the current standards but could with feasible improvements, and 17 percent cannot feasibly be improved to meet the current standards, and I assume that the Little Rock Airport falls into that 17 percent because it talks about impediments to improving the surfaces would involve environmental issues and physical problems.

MR. CASTELLANO: Those percentages are actual runways, not airports.

MR. SWEEDLER: I see, I see.

MR. CASTELLANO: Okay. So, I believe 1836, after it gets rehabilitated, I believe that should have a full runway safety area, if I'm not mistaken, from what I've read on it. So, those figures are actual runways.

MR. SWEEDLER: But that so, you're saying that the -- the runway involved here, 4 Right, is in the 25 percent that can be improved?

MR. CASTELLANO: 4 Right, 22 Left, is actually -- let's see. The approach to 4 Right already meets standard. It's a thousand feet. The approach to 22 Left is in the 17 percent, and it's not practical.

MR. SWEEDLER: Right. That's what I thought. Okay. I just thought I'd --

MR. CASTELLANO: And by not practical, what we mean is there's some impediment --

MR. SWEEDLER: Right.

MR. CASTELLANO: -- that just couldn't be overcome.

MR. SWEEDLER: But the further point -- just a further point here is the FAA estimated that to take those 25 percent of the runways and bring them up to current standards, that the price tag would be over a billion dollars.

MR. CASTELLANO: That's correct.

CHAIRMAN HALL: Did they ever consider an elevated structure to extend safety, the safety area over the floodplain, like is done at other airports, like LaGuardia? I know that would be an expensive item. I just don't know whether --

MR. CASTELLANO: I don't know that.

CHAIRMAN HALL: -- that was ever considered.

MR. CASTELLANO: I think there are other ways of doing that because what you're ending up doing is putting another right lane to support a pretty heavy, you know, extension out there. So, there are other ways, and I believe you will hear from Mr. Cook, who will probably talk about some of the advances in that area.

CHAIRMAN HALL: Right. Mr. Berman?

MR. BERMAN: No questions.

CHAIRMAN HALL: Mr. Haueter?

MR. HAUETER: No questions.

CHAIRMAN HALL: Mr. Clark?

MR. CLARK: Are either of you familiar with the typical design requirements of frangible poles? Frangible --

MR. SKILLICORN: Yes, sir, relatively familiar.

MR. CLARK: Okay. Is -- is it possible to create directionally-frangible poles, that is, in that environment out there, something that could withstand side loads to a high degree and then be very frangible along the runway length?

MR. SKILLICORN: Once again, we did -- we did look at that or look at the -- at the ability to have structures that would -- would withstand those environments. Again, you're -- you're dealing with random motion, icing, water flow, debris.

I don't know specifically that that was looked at, but the conclusion was, is that it would be exceedingly difficult, if not impossible, to establish something.

MR. CLARK: Well, is that a -- is that a general statement or is that specific to Little Rock? It snowed for the first time in three years here, and I can't imagine they have much ice on this river, especially in flooding season.

MR. SKILLICORN: Well, that -- that is -- and we -- with regard to ice, but my understanding again is that the -- when -- when the river flows, there is -- it's a very, very strong current associated with it.

MR. CLARK: Down in that floodplain area?

MR. SKILLICORN: Yes, sir, that's my understanding. In fact, the flood -- floodplain level is about 18 feet above the ground level at that point or can be at the maximum flood level.

MR. CLARK: So, if we built poles that were somewhat frangible above the 18 feet, I mean there's -- it seems like there's opportunity to diminish the risk that goes with the situation out there now.

MR. SKILLICORN: Sir, we put a man on the moon. I'm sure there's nothing that we can't do with enough resources, again whether it's -- both technically and economically feasible to do.

MR. CLARK: Well, I guess the reason that -- we put directionally -- we control some of the breakage on airplanes, such as the way engines may come off or the landing gears may fail. It seems that it's not that technically hard to accomplish some sort of directional frangibility. So.

That's all I have. Thank you.

CHAIRMAN HALL: This Jepsen plate, my question is this Jepsen Sanderson plate, which I assume the pilots use, doesn't show anything that -- that you got a short safety area, and it doesn't show the river.

MR. ZWINGLE: Yes, sir, it does show the river.

CHAIRMAN HALL: Where is the river? Oh, I've got a bad copy. I see. Okay.

MR. ZWINGLE: I've got the original here, if you'd like it.

CHAIRMAN HALL: Oh, it does have the river. Okay. Good, good. But the question is on the safety area then. Okay. The river's on here. Excellent. But I think that's already been discussed, but I was -- I was curious about the river, but I guess my copy was -- has been through the copy machine several times and didn't have the river.

MR. ZWINGLE: Mr. Chairman?

CHAIRMAN HALL: Yes?

MR. ZWINGLE: APA?

CHAIRMAN HALL: Yes.

MR. ZWINGLE: Could I ask one more question for clarification, please?

CHAIRMAN HALL: Sure.

MR. ZWINGLE: Thank you.

INTERVIEW BY PARTIES TO THE HEARING

MR. ZWINGLE: Gentlemen, would -- would the issue of approach light systems frangibility, the stanchion frangibility, be nullified if -- if the declared distance adjustment to Runway 4 Right was incorporated?

MR. SKILLICORN: I'm afraid I don't -- I don't understand the question. Would you state it again, please?

MR. ZWINGLE: Would the frangibility issue be nullified, be gone, not an issue, if the declared distance adjustment to Runway 4 Right were incorporated? Shorten the runway.

MR. CASTELLANO: No. You'd still have frangibility requirements. Even edge lights are frangible. They are frangible couplings. All signing. Anything inside the safety area is to be frangible to the extent practical, and that frangibility cannot exceed three inches above ground level.

So, even with the declared distances, you still have a safety area, and anything inside that safety area would still have to meet the frangibility requirement.

MR. SKILLICORN: Let me also add to that, is that it's -- it's the FAA's policy to have its entire approach lighting system frangible, even outside of the RSA, to the extent possible.

MR. ZWINGLE: Thank you very much.

CHAIRMAN HALL: The -- is it possible, Mr. Skillicorn, for you to list the navigational products that are there at the Little Rock Airport quickly or not?

MR. SKILLICORN: Well, of course, we have instrument landing systems on all -- all four runways. Actually, there are four runway ends. I don't think the 1836 does. RVR equipped on both of the parallel runways.

In fact, my understanding, this week, the plans to open up the 4 Left, 22 Right, runway for a Category 2 approach. We just installed a new approach lighting system on 22 Right for that function.

There is visual landing aids that would be either the VASE or the PAPE installed which provides vertical guidance. I believe that pretty much summarizes the navigational aids on the runway.

CHAIRMAN HALL: Okay. And how would those differ from a larger airport, say Memphis?

MR. SKILLICORN: They would not. The only thing maybe I could point out is that for a Category 2 or Category 3 approach, a more extensive approach lighting system is utilized for that. Again, Memphis, I believe, has multiple Category 2 or Category 3 approaches.

CHAIRMAN HALL: All right. Well, gentlemen, any comments that you all would make. We appreciate very much your coming down here, your attendance, and your participation in these hearings, and we appreciate the work you do.

Mr. Castellano, do you have any comments that you'd like to make in response to --

MR. CASTELLANO: No, I don't. Thank you.

CHAIRMAN HALL: Mr. Skillicorn?

MR. SKILLICORN: Yes, sir. I would like to add -- add one. I know that Administrator Garvey is certainly committed to improving safety. I think even during the course of these hearings, we have discussed the benefits, potential benefits of TDWR, LWAS, additional inspector capability, and not -- not the least is the ability to retrofit some of these non-frangible approach lighting systems around the country.

I don't -- I don't want an incident to occur at -- at another airport where we -- where we could have done something, but there is always competing interests. The FAA needs a significant and a stable funding source in order to accomplish these safety improvements. That is a message I think I'd like to leave.

CHAIRMAN HALL: Okay. Thank you very much.

MR. CASTELLANO: May I renege on my no?

CHAIRMAN HALL: Yes, sir.

MR. CASTELLANO: I just want to point out that the airport authority has done a very good job in the runway safety area controversy.

Recently, they were able to extend the runway safety area for the 4 Left approach by relocating a road and a railroad, and I'm sure that was at no small cost, and prior to the accident, the accident really had nothing to do with it, but prior to that, realizing the limitation on the approach to 22 Left, they had been talking about putting in one of the engineered materials arresting system, and I just want to make it clear that this was done earlier than June 1st.

CHAIRMAN HALL: Is there any schedule on that arresting system being put in in Little Rock?

MR. CASTELLANO: I believe it has now been moved up to -- I'm not sure if it's this year or next year, assuming we get funding.

CHAIRMAN HALL: Maybe the gentleman that speaks -- well, he's not with us.

MR. CASTELLANO: There's been talk about moving it up.

CHAIRMAN HALL: All right. Well, thank you. I think we need a break. I need a break.

MR. BAKER: Mr. Chairman, we would --

CHAIRMAN HALL: Yes, sir?

MR. BAKER: We would recommend that the most efficient way to handle this list of questions on these subjects would be to ask a combination of the airports and the ATC groups to pick them up.

CHAIRMAN HALL: Very well. Mr. Feith, can you handle that, please?

MR. FEITH: Yes, sir, and while I'm -- I just want to clarify one point that we've been talking about here. 4 Left that night was not closed. It was the -- the ILS system was down and NOTAM'd out, but the runway was actually open.

CHAIRMAN HALL: The runway was open, but the ILS was out?

MR. FEITH: Yeah. That's the one that they just certified for use right now.

CHAIRMAN HALL: Okay. Is that -- any questions on any of that?

(No response)

CHAIRMAN HALL: Now, while we take this break, we will have a vote and a poll, and everyone can come see Mr. Feith and indicate whether you want to go straight through or whether you want to take a break for dinner, but we will take a break and come back at quarter till the hour, and at that point in time, we will then have -- call our next witness, who is going to talk to us about the system that we've heard about that came out of a Board recommendation, and the FAA took the leadership on. We appreciate for this foam system at the end of the runway, arresting system.

We still have to hear from the Little Rock Fire Department, and I'm very anxious to hear from Stephanie Manus, who was a passenger, in regard to child safety seat. So, that's what's left of our agenda.

We'll recess until quarter till.

(Whereupon, a recess was taken.)

CHAIRMAN HALL: We will reconvene this hearing of the National Transportation Safety Board, and, Mr. Berman, I would appreciate it if you could introduce the next witness.

MR. BERMAN: I call Ms. Stephanie Manus.

Whereupon,

STEPHANIE MANUS

having been first duly affirmed, was called as a witness herein and was examined and testified as follows:

CHAIRMAN HALL: Ms. Manus, we certainly -- before Mr. Berman starts with the standard questions, let me tell you how much we appreciate your attendance here.

MR. BERMAN: Thank you.

INTERVIEW BY BOARD OF INQUIRY

BY MR. BERMAN:

Q Good evening, Ms. Manus. Could I ask you, please, just to start by stating your full name and address for the record or business address?

A Stephanie Manus. live in Baton, Arkansas.

Q Okay. That's fine. Town and state are fine. And could you tell me who you're accompanied by today?

A This is my husband Jimmy over here and my sister-in-law Nicole.

Q Okay. Welcome. Could you tell us your involvement in the accident? You're a -- you were a passenger aboard the flight, is that not correct?

A Yes.

Q Okay. Thank you very much. That's all the routine questions we have. We'll turn it over to Mr. Feith.

MR. FEITH: Thank you, Mr. Berman.

Mr. Chairman, in the interest of saving some time and providing Ms. Manus some privacy -- I mean this was a traumatic event for her. I had discussed with her earlier about just reading into the record a prepared statement about those facts that she felt comfortable describing to us about her -- the event, and, so, I'd like to have her read that, and then I'll just have some follow-up questions.

CHAIRMAN HALL: All right. Ms. Manus?

THE WITNESS: Mr. Chairman, I'd like to thank you for the opportunity --

CHAIRMAN HALL: Ms. Manus, I want to be sure everybody hears you. So, if you could pull that microphone close, I'd sure appreciate it. Thank you.

THE WITNESS: Okay. I'd like to thank you for the -- the Board for the opportunity to speak about the need of children's safety restraints in airplanes.

I won't be able to talk about the crash because it's too hard for me to talk about, and I'm sorry about that. I was traveling on Flight 1420 with my two children, Lauren and Emily. I was sitting in the middle, and I had them on either side of me, and we pre-boarded Flight 1420, and I -- I installed Emily's car seat that we use in our car for her.

Emily was 18 months old at the time of the crash. I was able to put the child restraint in with little problem. I put it in on the seat with the safety buckle that's in the airline seats.

The airplane was being tossed around as we descended into Little Rock National Airport, and the final impact was extremely violent with luggage and cargo being tossed all over the cabin. I held on tightly to my girls' hands during the impact.

I know that I couldn't have held on to Emily if she had been sitting on my lap without any restraints. Her injuries would have been much more severe than they were. I know that Emily's child restraint seat saved her life June 1st, 1999, and that's all.

INTERVIEW BY TECHNICAL PANEL

BY MR. FEITH:

Q First off, I'd like to have you take a deep breath and relax for a minute before I just ask you a couple questions.

(Pause)

BY MR. FEITH:

Q Given the fact that this is a very serious situation, and we consider it a very vital part of this investigation, I just want to ask you a couple questions regarding the use of the seat.

Have you traveled in the past with your children using the safety seat or was this the first time used?

A I have traveled using the safety seat before on planes.

Q Was that out of choice to use the seat?

A Yes.

Q And had you experienced any kind of difficulties in previous use, using the seat?

A No.

Q And can you --you said you were sitting in the middle.

A Hm-hmm.

Q Was -- was Emily in the aisle seat or was she in the window seat?

A She was in the window seat.

Q Was there any damage around her seat when you removed her from the seat and evacuated the aircraft?

A No.

Q Did you have any difficulties removing her from the seat?

A Not at all. It was like taking her out faster, you know, obviously, but taking her out of the car seat like I do in the car.

Q And that was a multiple-point harness?

A It was a five-point harness.

Q Did -- did you get any special handling using the car seat as you were boarding? Did you have pre-boarding with -- with the kids?

A Yes, I did.

Q And did you have any problems in -- in taking the kids on board? Were you traveling alone?

A Yes, I was.

Q Okay. And you didn't have any problems bringing the aircraft -- the safety seat on the airplane, installing it and settling the kids in?

A No.

Q You had sufficient time in the pre-board process to do that?

A I move quick, but --

Q Do you have -- did -- were you offered a discount of any type using this seat --

A No.

Q -- by the airlines?

A No, I wasn't.

Q Okay. And you said that you believe that the seat protected Emily from basically serious injury because it restrained her. Had the seat come out of the seat that it was fastened to or did it remain relatively intact and well secured in that seat that you had her in?

A It was in the same position when I -- that -- after I had installed it, and it hadn't moved.

Q And my lastquestion is the suggestions that you might have for other parents traveling with children similar to that of your own.

A I just would like them to know that they need -- need to use the car seat. We use it when we go to, you know, the store, to keep our children safe. A plane is no different. You need to do whatever you can to protect your children.

Q Unfortunately, I lied to you. I was handed a couple of questions while I was sitting here.

I failed to ask you, you were sitting in the rear of the aircraft? Do you remember what seat?

A 24C -- no. D. No. Wait. Emily was in --

Q What row -- you were in the back?

A 24.

Q 24?

A Yeah.

Q And you chose -- did you choose to put Emily in that window seat or was that a direction of a flight attendant or some guidance that you received from the airline?

A From a previous airline flight, they had told me to put her before in the window seat. So, I just did it because of that.

Q So, --

A No one told me to.

Q -- it was guidance from a previous carrier, not this particular carrier --

A Right.

Q -- on this particular day? And just to reiterate, Emily was 18 months. How old was your other child?

A She was four years old.

Q And did she -- just while we're talking about her, did she have any problems? She was put in with a lap belt.

A Hm-hmm.

Q Did she -- was she well secured?

A She was.

Q Okay.

MR. FEITH: I have no further questions, Mr. Chairman.

CHAIRMAN HALL: Ms. Manus, I don't -- you know, I want to -- you to say what you want to say. I do want to point out one thing, and that is that I want to acknowledge -- first of all, as you may have learned through after the accident, this has been a recommendation of the Safety Board for over 10 years, and one in which I was very pleased last December, Administrator Jane Garvey indicated that she was going to proceed into a rulemaking on this for the Federal Aviation Administration.

But your testimony is extremely important because many times rulemakings like that can take an extended period of time and sometimes do not happen at all, and I want to acknowledge and thank American Airlines.

You had no difficulty in taking the seat on the aircraft?

THE WITNESS: No.

CHAIRMAN HALL: We have had experience with some airlines that do give passengers a difficult time in bringing those seats on to their aircraft, and I appreciate the fact that you on this particular occasion did not have -- have any difficulty.

But with -- unless there's an objection from the parties, this witness -- it's late. She's got children at home. I'd like to be able to excuse her.

(No response)

CHAIRMAN HALL: Ms. Manus, do you -- it's your husband and sister-in-law, is that it?

THE WITNESS: Hm-hmm.

CHAIRMAN HALL: Are there any other comments that you all want to make? We just appreciate you being here. You got two girls?

THE WITNESS: Yes, sir.

CHAIRMAN HALL: So do I. How old are they?

THE WITNESS: Well, Lauren just turned five, and Emily's two.

CHAIRMAN HALL: Well, that's wonderful. That's wonderful. I got a birthday coming up February 1, mine's going to be 24. So, I'm a little -- you're just a little behind me.

Well, go home -- go home and take care of those girls, and we really appreciate your testimony.

THE WITNESS: Could I say one more thing?

CHAIRMAN HALL: Oh, sure.

THE WITNESS: I'd just like to stress that during take-offs and landings, turbulence and, you know, we're -- when we're about to land, there -- they advise us to put away our laptops, and the reason is, is that you -- you cannot safely hold on to those items in unexpected situations.

Our children are much more precious than a laptop computer, and something's got to be done about this because I wouldn't have Emily today, and I know that, if she hadn't been in that car seat.

Thank you.

CHAIRMAN HALL: Thank you very much.

(Applause)

(Whereupon, the witness was excused.)

CHAIRMAN HALL: We have two -- two more very important witnesses, and I'm going to request that we maybe expedite this next witness as much as possible because I want to hear from the Little Rock Fire Department, and that's our last -- last witness.

But we will stay here as long as everybody thinks it's necessary. Now, the hotel has -- has -- I don't know whether they have agreed to extend the hours or whether it is normal, but they have said that the restaurant will be open until 11:00 tonight. So, we will have a place to get some -- get some food.

Mr. Berman, if you'd call the next witness.

MR. BERMAN: I call Mr. Robert Cook.

Whereupon,

ROBERT COOK

having been first duly affirmed, was called as a witness herein and was examined and testified as follows:

INTERVIEW BY BOARD OF INQUIRY

BY MR. BERMAN:

Q Good evening, Mr. Cook. Would you please state your full name and business address for our record?

A My full name is Robert Cook, and my address is 3897 Country Club Boulevard, Chipley, Florida.

Q And by whom are you employed now?

A I am self-employed.

Q What's -- do you have a company or --

A I am a consultant now for Engineered Arresting Systems Corporation.

Q Okay. And how long have you been working in this capacity?

A In this capacity, since about 1988 when we started doing the first program studies on the soft ground arrester system.

Q Hm-hmm. Would you please tell me your duties and responsibilities as you work with that company?

A I'm -- my primary duties, I guess, are to supply the company with as much expertise as I have, as I've developed on the system itself, and do the technical design primarily for the arrester systems.

I do the performance analysis of the airplanes that are going to be engaging the arrester system.

Q Okay. And what -- what manner of education, training and prior experience do you have that's related to this function?

A I guess my aeronautical career started in 1944. I became a naval aviator at 1947. I started working for Wright-Patterson Air Force Base in 1951 as a research engineer up through 1979, and in that capacity, I was doing ground load work essentially for the Air Force vehicles.

I -- since that time, I've worked for the University of Dayton beginning in 1979 up to about 1990. Under the University of Dayton is where we started the original program for the FAA in determining the feasibility of this arrester system.

Q Okay. Do you hold an FAA airman certificate or any other certificates?

A No. I have a pilot's -- well, I'm certified and designated a naval aviator, I'll put it that way. I do have a commercial license which is long defunct, I'm sure.

Q Okay. Thank you very much.

MR. BERMAN: I'll turn it over to Mr. Feith.

INTERVIEW BY THE TECHNICAL PANEL

BY MR. FEITH:

Q Good evening, Mr. Cook.

A Good evening.

Q Unfortunately, Mr. Roman is stuck somewhere in a snowstorm, and, so, I'm taking his place, and I apologize for not having met you earlier. So, we do appreciate you being here.

A That's fine.

Q Just want to -- you provided a report to us, which I will talk about in a minute, but I'd like, for the benefit of -- of those of us who don't know what EMAS is, if you could just briefly explain it to us, really the type of material that it is, and -- and what it's intended to do.

A Okay. I do have a few charts that I prepared for this purpose, and if I could show those now.

To point out the engineered material or EMAS stands for Engineered Material Arresting System, and basically it is a passive system that decelerates aircraft simply by the wheels rolling through a very soft foamy material. By soft, meaning it's -- it's softer than what -- let me -- let me say it.

It's in the category like styrofoam. We have it as a strength of about 80 -- they call it Strength 80 because the average strength of this material in compression is around 80 psi, somewhere along in there.

This property or the material retains its properties over a very wide temperature range, humidity, which is necessary if this arrester is going to be effective at any particular airport at any particular time.

It is designed with the purpose of being compatible with all of the aircraft that are going to be operating from it, and in the process, we would -- we compare the performance and the loads against what the aircraft is designed for.

Now, have I answered your question?

Q That's a good start.

A I'll go ahead and give you some more pictures here then.

Q Well, if you have a picture of it, we might --

A Yes, I do. I'll show that. The next slide. Oh. You can see here this is one of the test EMAS that we used at Atlantic City and the airplane that we were using to test it. This particular EMAS was one of the final tests that we did. We went into it at 60 -- 55 knots, I believe it was, and we stopped in approximately 300 some feet, about 320 feet, I believe.

Q And typically this decelerates the aircraft and brings it to a stop without damaging the airplane?

A That's correct. This particular case, we did have a nose gear failure, but we were working with an airplane that was not certified to fly, and it had been used by the FAA at Atlantic City for many, many tests and was not -- I would say certainly not up to standards of most aircraft.

We didn't predict that there would be a failure. It just happened that there was.

Q And typically this material would start at the end of the runway and extend some distance into that safety area off the end of the runway?

A Yes. I have a picture here. This is the EMAS that's installed at JFK. As you can see, the end of the runway, which is right -- right along in here, and then we have what is considered or what is a ramp that goes up -- that elevates from zero to about three inches in order to get the aircraft started up into this material.

The material is initially at nine inches in height right along in through here. It tapers up at approximately -- well, to about a 160 feet until it reaches 24 inches deep, and for the JFK on further aft, it finally gets up to 27 inches deep.

The hole you see right here was as a result of a Saab 340 that overran at JFK and did stop the airplane successfully, didn't really break much of anything. I think we did damage a couple propellers, and I think maybe there was one small piece of the propeller that hit the side of the fuselage, and they had to patch that. Other than that, the damage was practically zero.

Q And about how fast was that aircraft going when it went into that?

A We don't have all of the data. I have some of the Saab data, and I'm going to say that it was in the order of 70 to 80 knots, which is all I can say right now.

MR. FEITH: Victor, can you put that picture back up, please?

BY MR.FEITH:

Q What is the distance off the end of the runway with the ramp and then the total distance of the material in this picture?

A Okay. From the end of the runway to the beginning of the EMAS material is 100 feet, and then the total bed here, I think, is a little over 400 feet. I don't recall. This has been installed for about three years, and I don't recall the exact total distance.

Q Now, given the fact that this is on this runway, are there any aircraft limitations? Will it handle all size aircraft?

A It was designed to handle all aircraft from DC-9 at about a 100,000 pounds up to 747 at 820,000 pounds. Of course, the deceleration will be different with each one.

Q Sure. Multiple gear airplanes decelerate better than single gear airplanes as far as main landing gear?

A No, not really. Multiple gear, like the 747, do give you an additional set of tracks or resistance because they have an offset set of gear that are the body gear, and then they also have the wing gear. This -- this provides some extra deceleration.

The bogey-type gear, everything follows in the same track as far as the aft wheels are concerned. So, we pretty much discount that, unless there is something in the computer program that we use that says that the rear wheels are being tilted down or into the foam material because the front ones are riding up a little bit.

Q And how about with regard to weight of the aircraft? Does that have any --

A Yes.

Q Any significant effect on this material?

A Yes. The weight of the aircraft sort of determines how far it's going to sink into the material, and, of course, the further it sinks in, the more likely it is to give higher decelerations.

Q And how about position of the aircraft? Does it have to go in nose first versus going in sideways to be effective?

A As far as us being able to analyze it, yes, but we have done a few calculations saying that the airplane can go in at -- at an angle or something of this sort.

Q Will it -- but does it degrade the performance of that -- the intended performance of that material if the airplane were to go in sliding sideways as was the case in this particular instance where, by the time the airplane went off the end of the runway, it was canted at an angle versus straight off the end?

A I don't know that I've made that good of a comparison yet. This is fairly new technology, and as a matter of fact, the Little Rock incident was the first case really that we kind of looked at that said that we had an airplane going in at an angle.

The formulation used to determine the drag is certainly somewhat different because we now have wheels that are going sideways rather than straight in. So, we have to account for the side areas as well as the frontal area.

Q And let's follow on with that. You -- you provided a report to us. You did a modeling of this particular accident for us based on the investigative data, and if you would briefly summarize that for us, I would appreciate it, because I know that what's in the exhibit, which is 16F, that was your report, and I know that you had an update to that report, and I would appreciate it if you could just explain briefly what it was that -- that you did, and what your results were.

A All right. Fine.

Q And while we're waiting, in this -- if you -- based on the picture and based on the intent, looking at that particular picture, the material is directly the same width as the runway?

A That's correct.

Q Is that intended to be -- is that -- was that purposeful or could it be wider than the runway by some degree to -- to take care of accidents such as 1420 that didn't go directly off the end of the runway but off the side of the runway?

A It could be as wide as you want to pay for essentially is what it amounts to.

Q Okay.

A We were asked by Mr. Roman to provide what the benefit of the EMAS might be for the Little Rock scenario, and to do that, we had to collect the flight data recorder information on speed, heading, aircraft configuration and some of the other parameter data.

We also had to get the aircraft physical data, which we didn't get until just a few days actually before the report was due. So, we did kind of rush to get this report put together.

Q Appreciate it.

A We had to determine what the aircraft conditions were at the end of the runway. This is what goes into the analysis method that we use, and these are what we call initial conditions, and the simulation that we did, and which I'll be showing you throughout here, is going to be a mirror image actually of what happened at Little Rock, and the reason that that is so is because I have a hard time trying to put a lot of negative numbers into something where there are negatives to begin with, and it's much easier to keep everything on a positive basis, and that's the reason for the mirror image.

We have to simulate the aircraft engaging the EMAS, and as you said, in this case, since we do normally make the EMAS at a -- well, the width of the runway, slightly bigger than that, but this decision was an arbitrary one, and I -- I'm not even sure myself why it was limited necessarily this way, but when the AIPs and all this kind of funding goes through, they -- I guess they need to keep the price in a certain range.

So, -- and then, finally, I think we'll compare the results with the thousand-foot safety area and determine what EMAS would have been required to stop this.

This first slide is the one that gives the track of the MD-82 from the very beginning all the way to the end. Our -- our interest begins really at the end of the runway, and everything that I'm going to say here really is concerned with what happens after it passes that point.

The reason that I am plotting it here was because I needed to find out how far down the runway that each one of the gear were going to be before it would engage the EMAS, if the EMAS were only along the width that -- of the runway.

As you can see here, the nose gear was in -- essentially within the boundaries of the runway and would have been in bounds of the EMAS. The left gear would have contacted the EMAS probably around 300 feet, somewhere in that neighborhood. The right gear went in at about a hundred feet. Now, that will be reversed on the next figures that I start showing.

Q And while we're talking about this, is there -- when you model an airport that's going to have EMAS, is it always the same distance? Did you always put 500 feet of material down off the end of the runway or do you put a thousand feet down?

A No. The -- the distance is pretty much dictated by what's available in many cases. Like at JFK, I think the total length that was available was about 550 feet or a little more than that. At other places, they may be on the order of 300 feet or less.

I don't think we would probably -- or at least I'll put it this way, we'd have to study pretty hard. If they get too -- too small, then you begin to wonder whether you're going to have an effective system or not.

This -- I needed to find out really where -- what the final speed was as the airplane went off of the end of the runway, and to do that, I've plotted essentially the track of the airplane, starting back at about minus 700 feet from the end of the runway, and I wanted to find out where the aircraft had the same heading as the runway itself, and it turned out that at this point, it was going at about the same direction as the runway or about 42 degrees, 43 degrees.

Oops. I'm sorry. Move forward. This is a plot of the flight data recorder information. The bottom line that you see down here is the heading as reported from the flight data recorder data. The top line up here is the speed that the aircraft was traveling.

The 700 feet that I was pointing -- noted was at -- to give the 42 degrees roughly at the airport or 43 degrees at the runway heading, so that I could find a point now that agreed time-wise along with the distance. I needed then to find out where the end of the runway was. So, I integrated the velocity of the airplane from there to find 700 feet, and it turns out -- I think that pushed this curve up just -- just a tad.

Could we move the curve upward just a little bit? It has the time on it. There we go. But as you can see, we -- the -- at the 700 point, we were roughly at about 19 seconds, and then at the end of the runway, it corresponded to about 23 seconds on the flight data recorder information.

Then, of course, at that point, you see that the velocity that we obtained was about 98 knots roughly that it left the end of the runway. I think there have been some other numbers. We're at least in the same ball park as they were.

Next. The airplane was in a highly-yawed state as it left the end of the runway, and as you can see, this zero here depicts the end of the runway, and I plotted essentially the distance between the nose gear and the main gear, and then looked at the path that was going along or that it was going along, and the angle involved here then is the yaw angle that the aircraft was going during the -- at the point that it left the end of the runway.

Q And again, in going back to an earlier question of mine, is that yaw angle excessive? I mean it will degrade the performance of the material because it typically is designed for airplanes going straight off?

A Yes, that would degrade the performance of the airplane. The material doesn't change.

Q Yeah. That's --

A Yes.

Q That was bad terminology. Yes.

A To make sure that we had everything pretty well lined up, and that we had the right parameters and everything, I ran the computer program to see whether or not we were tracking the same kind of tracks as were in the Little Rock accident, and as you can see here, I've plotted the nose gear along in here in the red line. The blue line is the left main, and the green line -- the green line is the right main, and I've plotted on there Xs essentially which are the measured values that correspond to the same track that was shown -- I showed on the first chart, where we had the whole track of the airplane.

We can see that this model was doing a reasonably good job of following the same track as what the airplane did.

I was also interested in finding out whether the speed agreed with the one where the airplane left the runway, and again we see that the airplane was leaving at about 98 knots at this point, and the black line here is the simulated one, and the red line that you see here was the one that came off of the flight data recorder. So, we apparently are tracking that, also.

This is a result of the -- well, it is the performance that we expected to get if there were an EMAS at Little Rock. The EMAS that we designed here does consider all of the aircraft that operate out of Little Rock, other than some of the commuter smaller aircraft, but I think we looked at the 737 and primarily the 727 and those type of aircraft, MD-80, and this -- this particular EMAS would have had a hundred-foot distance just like the one at JFK which we ramp up to approximately three inches high.

Then it would go over a 120 feet up to a height of about 21 inches and would terminate at around 400 feet because that's about the end of the safety area that's available.

I should point out that all of these have to be put on a hard -- well, I won't say -- it has to be a surface that can handle at least one or two passes of an airplane without sinking in to it. It doesn't have to be the full strength of the normal runway, but certainly strong enough that we can maintain boundary conditions for the airplane.

Q And, so, here at Little Rock, -- I mean are you doing any work here at Little Rock for real?

A No, not -- well, I -- let me -- let me qualify that a little bit. I -- I think there have been discussions, and I think the airport can probably answer that better than I can really, as to where -- where we're going there.

Q But are you familiar enough with -- is that particular part of the runway -- end of the runway capable of supporting an EMAS system?

A At the present time, it is not. It's a grass surface, and that is not sufficient or adequate for installing an EMAS.

This chart shows the -- well, I'd like -- let me back up here a minute. Before I get rid of this chart, I think here you'll see that we started off at the 98 knots, which we obtained from the data, and as the airplane goes off of the end of the EMAS, the main gear -- this is a plot against the nose gear travel and the air speed or the flight speed, and as you see, the speed decays as it goes out and would finally come off at about 70 knots after the main gear had finally left the end of the EMAS.

CHAIRMAN HALL: So, the bottom line is it would work -- would it work here or not?

THE WITNESS: It would not have stopped the airplane.

CHAIRMAN HALL: Right.

THE WITNESS: It does provide a pretty good reduction in the amount of energy that would have been left in the airplane in terms of an accident. The airplane during the accident, I think, left the end of the safety area at about 85 knots, somewhere along in there. We reduced it from the 85 knots down to about 70 knots.

BY MR. FEITH:

Q Well, --

A The -- go ahead.

Q -- I was going to say, let's take it one step further. Since it didn't go off, directly off, and it caught just basically the front end of the airplane, would the drag have caused the airplane to slew around even more than it did, so that it would have been more tail first continuing in that direction off the end of the runway?

A Let me give you the next slide. As a matter of fact, I think that will answer your question. This is the track that actually happened or at least as our simulation, and I think you can see here that it did not do any wild gyrations. It did start turning or it does rotate into the direction more than the aircraft did but not a whole lot.

Q Okay. So, as the Chairman has asked, basically it would have slowed the airplane down but wouldn't have done really what it was designed to do in -- in preventing --

A I have to answer that by saying that the design of the EMAS at present is controlled somewhat by a circular which says that you design this thing for 70 knots. So, as -- as the maximum accident -- exit speed. So, we used that as -- as the basis for designing the EMAS.

This doesn't say that you have to quit there. It just says that that's what the circular says right at the moment. So, we designed it that way.

CHAIRMAN HALL: Well, now, where did that come from, Mr. -- Lyle? Do you know where they got the 70 knots from? Has somebody done a study on overruns?

MR. STREETER: I don't know the answers, sir, but the data exists, and I'm fairly certain we can get everything together for you.

CHAIRMAN HALL: Yeah. If we could get that.

MR. FEITH: Yeah. We'd appreciate it, Lyle.

CHAIRMAN HALL: Is that it, Mr. Feith?

MR. FEITH: I was just going to say.

BY MR. FEITH:

Q In looking at this, all you would have to do basically is pave off the end of that runway to accommodate an EMAS system? It is -- you said it was grass. What would you have to do to prepare the end of that runway here at Little Rock to put the EMAS system in?

A What we'd have to do to install it?

Q Not -- not -- yeah. Reader's Digest version.

A I guess I missed your question.

Q You have to make it a hard surface off the end of the runway. You said that it's grass off the end of the runway right now.

A Right. It does have to be put on it. So, you would have to install a hard surface, yes.

Q Okay. Very good.

CHAIRMAN HALL: All right. Where do we pick up? Is it the National Weather Service's turn? I believe so. Did you say no questions?

MR. KUESSNER: No questions.

CHAIRMAN HALL:The Little Rock National Airport?

MS. SCHWARTZ: No questions.

CHAIRMAN HALL: The Little Rock Fire Department?

MR. CANTRELL: No questions, sir.

CHAIRMAN HALL: The Federal Aviation Administration?

MR. STREETER: No questions, sir.

CHAIRMAN HALL: Boeing Commercial Airplane Group?

MR. HINDERBERGER: No questions, sir.

CHAIRMAN HALL: American Airlines?

MR. BAKER: No questions.

CHAIRMAN HALL: And Allied Pilots?

MR. ZWINGLE: No questions.

CHAIRMAN HALL: Well, Mr. Cook, I don't know. Does the Board up here have any questions?

(No response)

CHAIRMAN HALL: We're very interested in that, and I'm going to try to make a -- I've been trying to get up to New York to look at the one that's installed up there, but given the time and the fact that we still need to hear from the fire department, I'm going to give you an opportunity, as we've given all the witnesses, if you have any comments that you think are things that the Board would consider.

You've obviously looked at this accident sequence as a part of -- part of your work. We would welcome those at this time.

THE WITNESS: Well, I think the one comment that I would like to put forth here is that when we started this program to determine whether an EMAS was going to be effective or could be feasible even, it was -- didn't take long to find out after reviewing the accident reports and everything else that if we were going to put something out there, it was certainly going to have to be compatible with whatever the airplane was capable of taking.

Otherwise, we were going to end up with the same situation that we normally have, which is the airplane comes apart and that sort of thing happened. So, to me, the most important thing probably here is that the EMAS provide a safe way of arresting an aircraft at the end, and I guess that's about essentially what I wanted to say.

CHAIRMAN HALL: Well, it's certainly common sense, you know. We've got Eagle Mountain in Tennessee, and we have truck runoff areas that -- so, I don't think this is any -- but it has -- it did -- the Saab 340 that I don't have the details on that, but that obviously prevented -- it was the feeling that prevented that particular aircraft -- this was a larger aircraft from -- from going in the -- in the river there, and it's -- and there were no injuries that I'm aware of --

THE WITNESS: That's right.

CHAIRMAN HALL: -- in regard to that -- that particular event. So, -- but the 70 miles an hour is something I'd like to know where the data supporting that comes from, and whether it -- I guess I do have one question.

Could you design it for a higher speed if you --

THE WITNESS: We certainly can.

CHAIRMAN HALL: You can?

THE WITNESS: Yes. It -- it's a matter of, you know, deciding what speed you do want to arrest an airplane. I think we can design it to satisfy any reasonable requirement.

I -- I am not sure what our high speed might -- the high end, but I think if you were to fly into this thing, I'm not sure it would be very compatible, but on the other hand, I think speeds that normally you would expect to see, like an RTO or something of that sort, certainly could be designed for.

CHAIRMAN HALL: Okay. Thank you very much. Now, I don't want to preclude the esteemed Board of Inquiry, but we will -- Mr. Cook, thank you for your testimony, and I'll ask Mr. Berman if he would please call our last witness.

(Whereupon, the witness was excused.)

MR. BERMAN: I call Mr. Larry Tyner.

Whereupon,

LARRY TYNER

having been first duly affirmed, was called as a witness herein and was examined and testified as follows:

INTERVIEW BY BOARD OF INQUIRY

BY MR. BERMAN:

Q Good evening, sir. Would you please state your full name and business address for the record?

A My name is Larry Tyner, and my business address is 1000

West 7th, Little Rock, Arkansas.

Q Thank you. And who is your employer, sir?

A The Little Rock Fire Department.

Q What's your present position there?

A I hold the position of a district chief.

Q How long have you been in that job?

A District chief since 1992.

Q Will you tell us, please, about your duties and responsibilities as the district chief?

A Basically to supervise and direct fire-fighting personnel and equipment in fire suppression, rescue operations, and other emergencies, and to be responsible for the fire stations in my assigned district, to lead, guide and direct personnel in training, fire prevention, pre-fire planning, personnel development and any other duties the fire chief may assign.

Q That last big catchall.

A Yes.

Q Would you tell us, please, about the education and training and experience that you had to prepare for your job?

A 30 years' experience in the fire service. All have been with the Little Rock Fire Department. I've been a chief officer since 1992, attended in-house training programs the last 30 years, covering fire-fighting and related other subjects, have attended the ARFF training and yearly hot drills in past years, participated in the last airport disaster drill, and I have a Bachelor's degree from the University of Arkansas, Little Rock.

Q Do you have certificates you can tell us about that are related to your profession?

A No, sir. Other than the -- the ARFF training certificates and so forth.

Q Hm-hmm. Okay. Thank you very much.

MR. BERMAN: We'll turn it over once again to Mr. Feith.

INTERVIEW BY TECHNICAL PANEL

BY MR. FEITH:

Q Thank you, Chief, for staying around and moving out of rotation.

A You're welcome.

Q Would you just -- we -- we have a lot of information in the factual record that we gleaned from Day 1. I would just like to have you briefly describe your -- your initial response to the accident site from your perspective, please.

A Okay. First time the -- our crews were aware that an incident had occurred, they got a call on the ring-down phone from the Little Rock Tower. That -- they have a direct line to the tower. When they pick up the tower phone, it rings in the fire station, the airport manager's office and also an airport maintenance office.

So, our personnel answered the telephone. The tower controller said that he had lost contact with an American Jet, Runway 4 Right, and that he did not know where he was. Our fire-fighter repeated "You've lost contact, and you don't know where he is". He said, "That's correct."

So, the other fire-fighters were out in the station by that time and probably in under a minute, they were out on the field in the red ball units. We have three crash units located at the airport, Red Ball 1, 2 and 3, and as they left, they asked permission from the tower to go to the end of Runway 4 Right via Taxiways Tango and Romeo, and they were granted that permission.

And also one of the airport maintenance units that has been called Mobil 5, it also picked up on the conversation on the telephone from the maintenance office, and they had also requested from the tower that they be allowed to accompany the red ball units to the end of 4 Right to investigate.

About the time the red ball units got to Tango, they had called --

Q Can I just interupt you one second, Chief?

A Yes.

MR. FEITH: Victor, can you put up the airport diagram, please, so we know where the Chief is talking about? It's that new one, the entire airport lay-out. That one. And if you could probably just zoom in on the right side of that picture. Right.

THE WITNESS: I have it, yeah. This would be -- this is the ARFF station right here. We had to travel across the east ramp to Taxiway Tango, which would be approximately right here, then down to Romeo, all the way down to --

MR. FEITH: You're making me dizzy, Victor.

THE WITNESS: Yeah. All the way down -- all the way down to 4 Right, right here in this area, and that's where they stopped, and they didn't see anything at that location.

So, they radioed back to the tower and said, "We're at 4 Right. We don't see anything." The tower replied with "the last time I saw him, he was just past the mid-point. If you would go down to the other end, please, that's where he would be."

Still raining very hard. You've seen the tapes. Visibility's very poor. The crash units are maybe 10 feet apart. They can't hardly see each other. They don't know -- still don't know the location of the airplane or even if it did crash. They didn't know is it stuck in the mud somewhere? Did they decide to take off and go around? No one knew yet, but in case the airplane had -- had begun to come apart somewhere on the runway, they weren't sure, but there maybe pieces of aircraft on the runway. Some passengers may have been deposited on the runway. They didn't know.

So, they were in a search mode, and they were having to drive fairly slow because of the poor visibility. The red ball units themselves were hydroplaning because it was raining so hard, and like I say, they're going slow. They're trying to search. They don't want to run over any parts of the airplane and damage their equipment, and they don't want to run over any people.

So, they traveled 7,200 feet from the end of 4 Right down the runway, and until they get down here to about Taxiway Whiskey would be right here, they finally saw some tire tracks off in the dirt.

So, they knew something had happened by that time, but they still couldn't see, even though the aircraft is just down here below -- below the end of 2-2 Left down this embankment burning. They still can't see it until they get it right here in about this location, and then when they stopped at the end of 2-2 Left, they could see it over the -- over the riprap embankment down in this low-lying area between the runway and the river.

At that time, it was burning. The only way they could get there was to make a u-turn right here, go back down the runway some, I think, close to 1,750 feet, to -- to this connector road, down this connector road to the perimeter road, turn left, unlock a locked gate here, push the gate back, get back in their apparatus and then drive the perimeter road back down to the crash site before they could start putting water on it, and once they did reach the site, the fire was extinguished fairly quickly, from all accounts, in less than a minute.

BY MR. FEITH:

Q Using water or foam?

A A combination of water-foam mixture.

Q We had -- we had some concern because the reports were that it took an excessive amount of time, and excessive, of course, is subjective and relative, but we know that it took 13-15-16 minutes, something like that, to get to the accident site and actually start putting out fires and aiding survivors and that kind of thing.

Would there have been any possibility of getting any of your equipment down off the end of the runway without having to back track on the runway, go through the gate, take the perimeter road and get down there?

A No, sir. Once -- once they reached that point at 2-2 Left, the only way to get down there would be to retrace their steps back to the connector road and then to the perimeter road itself.

CHAIRMAN HALL: Vic, put that picture up, if you would, we have of the plane or showing the rock -- not the runway but the actual photograph of the -- the plane.

MR. FEITH: The one we used earlier, Victor.

CHAIRMAN HALL: Yeah.

BY MR. FEITH:

Q While we're waiting for that come up, Chief, what -- is your -- is your facility staffed 24 hours, seven days?

A Yes, sir, it is.

Q By how many people?

A Four fire-fighters, first shift.

Q And that's minimum by standard, by Little Rock requirements, by FAR?

A I don't think there is a requirement according to FAA 139 on manpower requirements, but -- but we do have four people there to man those three units, and I believe those three units do exceed FAR requirements for -- for water and foam.

Q Okay.

MR. FEITH: Is that the one you want, Mr. Chairman, or do you want the other one?

CHAIRMAN HALL: Yeah. That's -- that gives you a good --

a good view of it, yes.

BY MR. FEITH:

Q Okay. So, you've come down that perimeter road. Your people show up. How many vehicles initially arrived on scene to begin your -- your response?

A Okay. We had our -- had our three red ball units that were there. They were there approximately two to three minutes before our off-airport help started arriving.

One of the first units to arrive was a heavy rescue unit that is equipped for extrication purposes. It was manned with anywhere from five to seven people that night. They got there within two minutes, and like I say, the fire had -- the main body of the fire was extinguished very quickly in under a minute, and at that point, the fire-fighters were off using hand lines to extinguish small fires up under the wings and the fuselage, so that this enabled our Rescue 1 personnel to go ahead and be able to enter the fuselage of the aircraft and start rescuing people.

Shortly behind them, another company from the same station, Engine 2, arrived and also started with the -- with the rescue process.

Q How many people would have been on scene when the three red balls arrived on scene, total?

A Just with the three red ball units there?

Q Prior to the off-airport response.

A Just those four people, sir.

Q Okay. So, we had four people out there.

A Yes, sir.

Q One, two, three positioned the truck to put the fire out. How did they extinguish the fire?

A They used the rough turrets and bump -- bumper turrets.

Q Was that --

A And then to extinguish the main body of the fire, then they got off with a one-inch hand lines.

Q Did that take three trucks to do or was one capable of doing it with one person?

A They -- they all three applied foam and water to different areas of the aircraft.

Q So, at this point, we have the three trucks, the three drivers -- three firemen in each of those trucks responding to put the fire out, yet -- and at that point, nobody is assisting victims at that point or anything else?

A No, sir. Their main responsibility at that point -- these Class B fuel-type fires can -- can accelerate very quickly. Their main objective was to put the fire out so that in fact rescue could start taking place.

Q Do you think that -- at that time when you started that fire-fighting effort, was it still raining very hard?

A Yes, sir.

Q And was there hail with that rain?

A Rain, hail, lightening, wind. Yes, sir.

Q Do you think that the -- the environmental effects, the heavy rain, may have knocked down the fire, and it could have been worse or do you think that there was no effect by that heavy rain?

A I believe the -- I believe the fire did -- the -- I'm sorry. The rain did help with fire extinguishment and keep it abated to some extent. I sure do.

Q And how long after your people started fire-fighting efforts did the off-airport vehicles arrive and then begin their -- their integration into your process?

A Okay. Within two to three minutes, we had our Rescue 1 unit, and then a minute or two later, another engine company, and then they just started coming in every two or three minutes until we had enough help there to handle the situation.

Our incident commander had set up incident command at the ARFF station, and he was in the process of having extra companies just to keep feeding them to me until I told him I had enough. So.

Q Okay. I want to ask you some questions, and we'll go back to what happened on scene because I have some questions there, also.

When you get notified from the tower, is there any standard phraseology between the tower controller and the fire house as to where an airplane has gone down, whether it's the approach end, departure end, middle of the airport? Is there any standard phrases or key words or whatever that describe an event?

A We normally use runway numbers and taxiway numbers where they intersect with runways. In other words, if he would have been down at, say, Tango and 4 Right, that's probably what he would have given, Tango and 4 Right.

Most of the time, instead of using arrival and departure, say he was going right on Romeo to 4 Right, he wouldn't have said the arrival end of 4 Right, he'd have just requested permission to go to 4 Right. Had he been going to the departure end of 4 Right, nine times out of 10, they'll use 2-2 Left. So, that's basically the way we communicate.

Q Okay. So, -- and all of your people are familiar with that logic when it comes to reporting which end of the runway the airplane may be?

A Yes, sir, that's pretty standard.

Q So, when the -- when the controller called and said we got an airplane down on 4 Right, your -- your people assumed the approach end of 4 Right because that is the way the terminology is set up --

A Yes, sir.

Q -- to respond?

A Right, and that's the end, and it has the big 4 R written on it. So, you know it's pretty -- pretty easy to correspond to that.

Q And it's fair to assume that had the controller known that it was at the -- at the departure end of 4 Right, which is 22 Left, --

A Yes.

Q -- he would have told your people the airplane has crashed at the -- at the end of 2-2 Left?

A Yeah. More than likely, sir.

Q Okay. Has this presented any problems in the past as far as confusion and -- and delayed response? And the reason I'm asking is because we had a 16-minute delay here, and based on what you just told me, it wasn't until your people arrived at the approach end or at 4 Right that the controller then said, "Well, the last place I saw him was mid-runway going that direction, go down that way"?

A Right. No, sir. Prior to that, to my knowledge, we've had no problems.

Q Let me take that one step further. Have you talked -- well, are your people -- and I hate to phrase it this way, but the fact that -- was there any more querying going on or, you know, in your debrief since this accident, any more discussion by your fire-fighters that they should have been talking more to the tower and trying to get more information as they were going out there?

I know that they were in the search mode because they didn't know what they were getting themselves into where they were going, and -- and they were looking for an airplane, people, etc., but to try and hone down exactly -- the thing that bothers me is that it wasn't until they arrived there, they made the tower call, and they say, hey, there's nothing out here, and the guy goes, "well, last time I saw it, it was mid-point".

A Right.

Q Why didn't that information come up on the initial call?

A I can't explain that, sir.

Q Do you know -- we talked about this earlier with one -- with the FAA witnesses, regarding the 139 plan and the grid system that should be in the ACM.

Do you have -- I presume you don't have a grid system because I --

A No, sir, we do not.

Q What form of communication or property detection as far as the airport property is concerned, what system do you use in lieu of that grid system?

A Okay. We -- like I say, we go by runway numbers, taxiways, for our alert positions. We have positions that are pre-determined along the taxiways for Alert 1 and 2 type situations. All of our crash units know where they are. All of our off-airport units that respond to alerts know where those pre-determined positions are. So, there's never been any confusion to my knowledge using that -- that method.

Q Okay. And has there ever been any talk about having amphibious vehicles? I didn't see any when I was in the -- in the fire house the other day, and given the fact that you have a large body of water off the end of the runway, and given the fact that you will be probably the first responders on scene, is there any consideration given to having an amphibious-type vehicle like a duck or whatever that would be able to begin any kind of water rescue operation?

A No, sir, not to my knowledge. We have at one of our stations that responds to the airport on alerts, we have four -- four wave runner watercraft-type vehicles that we can launch and get there pretty quickly.

We also have a list of about eight different agencies that will be able to supply us boats and watercraft in case -- in case one did end up in the river.

Q Do you have any -- any large vessels, such as barges -- the thing I'm concerned about is statements that were made earlier by the FAA, and the fact that when the river does come up, and the current -- I'm not familiar with the current, but I would presume that it's probably seven knots, 10 knots or faster, given the way it's been described, especially when the river is up, that had that airplane been in the water, that most likely it wouldn't have been at the end of the runway anymore.

I'm basing that on seven knots of experience out in Subic Bay that carried an MD-11 halfway around the island, and, so, what would you do to try and preserve the airplane from -- from moving downstream while you're trying to do the rescue operation?

A We have, like I say, these other agencies that we have listed in our emergency plan. Our Pulaski County Sheriff's Department has a barge-type boat that they can get underway fairly quickly. The Corps of Engineers has a fairly large type water rescue boat. Little Rock Harbor Service has a tugboat that can be incorporated. The Port of Little Rock has a couple of boats. The Coast Guard Auxiliary has from five to eight fairly large-sized boats, and North Little Rock Fire Department has a barge that they can launch and get to the area fairly quickly. So, --

Q Is there --

CHAIRMAN HALL: Mr. Tyner, could I -- excuse me, Mr. Feith. Could I just ask a question? Have you done any drills with any of those organizations?

THE WITNESS: Yes, sir. Our last -- our last airport disaster drill, we incorporated water rescue in with that.

BY MR. FEITH:

Q And how much time was it in response from the time you called them and said, hey, we need you now? How long did it take to get all of that to an accident scene?

A Yeah. I'm really -- I'm really not sure, Mr. Feith, on the times that it took them to get there. I was involved in another -- another aspect of the drill, but some of them could get there fairly quickly, and some of them, it would take a little longer. So, I'm not sure of the average time actually that it took -- took them to get there.

Q Is that part of the emergency plan when -- and I guess I should have asked the FAA this -- but is that part of the emergency plan when you -- when you have to go out and do your drills and that kind of stuff, and you have to incorporate all the various agencies, is that not incorporated and timed out so that -- you as the chief have to anticipate and know that when you pick up the phone, and you say I need your boat now, you can almost time that, you know, six minutes --

A Yeah.

Q -- from now, that boat's going to show up or two hours from now, the boat's going to show up.

A Yes, sir. Yes, sir. I'm sure that information's known. I just don't -- don't have it available with me.

Q What kind of responsibility -- and again I want to keep this brief and to the point, but I think these are questions at least I have a concern about.

When your people first show up on scene, what are they trained to do? I know that there was a fire going. So, that was their first priority. But then if you can just give me, you know, a few basics, the Step 2 and Step 3. What are their then immediate concerns after that fire is knocked down or at least out?

A Okay. After -- after our off-units get there with their three vehicles and their four people, like I say, the first priority is -- is fire control. Once that is accomplished, then, of course, they can get off and -- and start assuming some rescue responsibility, treating victims and so forth, as we wait on our off-airport units to get there, but fire control and providing a way of escape for the people, like I say, is their first priority.

If there is no fire, of course, they would immediately start rescue efforts, and after the fire is out, then they can start assuming some of them while -- while we wait on our other help.

Q And I mean no disrespect, and I -- I -- this is -- I'm going to qualify this before I ask the question because being here the last three days and having family members and survivors of this accident being -- walking around the halls, we get questions, and it was brought to my attention regarding the initial response when you show up on scene, that some of the passengers that were on the airplane had been asked by some of the firemen on scene to go back and help rescue other people that were in the aircraft and provide assistance to them after they themselves had just come out of the aircraft, and I want to -- I want to -- I'm asking you because that was asked of me.

A Hm-hmm.

Q It was brought to my attention, and I'd like to have, you know, your perspective on that.

A Yes, sir. I wasn't aware of that happening. This is the first time it's been brought to my attention. I know that several of the survivors were helping us, and because I was trying to maintain -- make sure that the scene was maintained securely, and I was noticing several people in civilian clothes helping our people triage and carry victims back up to -- to MEMS triage site, and I would stop and say, "Sir, I'm sorry. Who are you, and who are you with?" And they would say, "I'm a passenger. I just want to help."

So, that's what I ran into. I don't know of any of our people ordering any to help. I do know that several of the passengers so graciously volunteered to help until we got enough help there to take -- take the situation under control.

Q Well, and I'm going to talk to my superiors here, but I -- that's an aspect that was just brought to my attention, also, and I wish Mr. Roman was here, and I will definitely bring it to his attention because I'd like to follow up on that because --

A Yes.

Q -- that is a concern because of the way it was characterized to me is that there were some passengers that were -- they were requested to go back by fire department personnel, and I just want to make sure that the record reflects, you know, the accuracy of those -- of those accounts.

A Yes. If it -- if it did happen, it shouldn't have happened, but this is the first I've been made aware of it, sir.

Q Okay. In giving a general assessment of the response, do you believe that you had sufficient equipment and personnel through the various stages, the initial response, then probably the mid-point response, and then the clean-up phases, to do all the things you needed to do, which is the first part of the question? And then, second, would you briefly just tell me how command and control was established, and what the -- the interaction is?

We've had a problem in the past. We had an accident in Charlotte, North Carolina, where we had a problem with command and control when we had not only airport fire department personnel but also off-site personnel then showing up, and there became a bit of a delay in who was going to do what because they couldn't decide who was going to be in charge.

A Hm-hmm.

Q And given -- and it was similar circumstances where in Charlotte, the airplane started on the airport, went through the boundary fence and ended up off the airport.

We basically had the same type of situation, a little more control. So, I'd like to have your assessment of that, also.

A Once -- once things finally started rolling, help started arriving -- started arriving, and -- and we had plenty of help, within a fairly short time considering this was a very busy night in Little Rock, severe storm going on. We had a house fire going in the western part of the city. We were responding to several fire alarms due to the severe lightening in the area.

But all in all, the communications did a good job of getting us the help we need. A lot of the off-airport companies had already been up and about responding to other alarms, and they -- they happened to hear this on the radio. So, they self-dispatched themselves rather than waiting on communications to dispatch them.

I knew with an incident of this size, that I was going to be needing a lot of help, not only from off-airport companies that -- that normally run the airport and have knowledge of where the gates are, where the runways are, where the location was, but I was going to have people coming -- needed a large amount of people, and we were going to have people coming in from the other end of the city that weren't that familiar with the airport, and probably also some mutual aid companies coming in from even other cities that certainly weren't familiar with the airport.

So, on my way, I had requested that the Little Rock Police be notified to man each perimeter gate around that particular runway, to open the gates and be ready for whoever came in to give them access and direct them to the site.

I wanted whatever direction they were coming from, that whatever gate they came upon first, that it would in fact be open, and there would be someone there to direct them around to the crash site. So, -- so, I think they -- I think the Little Rock Police did a good job of maintaining security. They were letting our people in, MEMS people in, mutual aid people in, while keeping persons out that shouldn't be there.

Q Let me interrupt you right there. The Chairman and I took a tour courtesy of -- of the airport. We drove around the perimeter. We went out on the runway. We went to the end, and then we drove back, went down the -- down that access road to the perimeter fence.

How long does itake your people to open up that -- that fence?

A You're talking about the gate that --

Q The gate that has --

A -- had access to get to the crash site?

Q The one that you go down the hill --

A Okay.

Q -- where the chain is wrapped around --

A It takes about -- we had reports from 20 to 30 seconds, and I -- and, personally, I put one of the men in my car the other day. We did that same thing. The time he got out of my vehicle with the key, unlocked the gate, opened it and got back in my vehicle, and we drove through, it was about 45 seconds. So, not -- not really much time was wasted getting through that gate.

Q How about versus having an automatic gate with a garage door opener or at least a key card access so -- I noticed that it was -- and again there was no accident sitting down at the end of the runway. So, there was no cause for being in a rush.

A Hm-hmm.

Q But I watched them fumble around with that chain and the lock and everything else, --

A Right.

Q -- and on a cold and stormy night, whether it's in June or right now, where it's cold and that kind of stuff, the lock is iced or whatever, I mean it's going to take more than 30 seconds, I would believe.

A That could be a problem. We also have some electronic gates that you get in with a card access, and sometimes, you know, it takes them 15-20 seconds to go ahead and open for us, too. So, there could be a little delay there but maybe not as much as the key and a chain system would.

Q Okay. You're familiar with the DEV System that we talked about earlier with the FAA. What's your assessment of it?

A I think it is a very good system. I'm not sure that it would have worked very well in our situation. I'm sure that we may have other incidents where it would be -- be vital -- vital to us getting to the site.

Our chief right now is looking heavily and studying -- studying this type of system, and I think very shortly, we'll be submitting a proposal to our airport authority to discuss means to maybe purchase some of this for our use in the future.

Q And I have a question from -- from Larry. Talking about the MEMS personnel, and the MEMS was the -- the -- I don't know exactly what the alphabet acronym stands for, but it was the emergency response service, I presume.

A Metropolitan Emergency Medical Services, sir.

Q Okay. The personnel reported that they initially went to a locked gate and had to reroute which caused some delay.

Can you tell me what that was about, what was -- did they not have a key to the gate or what happened there?

A Exactly. They went to one of the gates that happened to have a padlock that you had to unlock. They didn't have the key to it. One of MEMS' supervisors had followed me down to the crash site in my vehicle. He was wanting to know the best way to get his units in, and I told him Gate 37, which is the gate right at the end of Runway 4 Right, and it was pretty quick access when you get off the freeway.

So, I knew a lot of his units and probably a lot more of our outreaching units wouldn't exactly know where the gates were, and I thought that that would probably be the easiest one. It has a key punch, punch in a four-number code, and the gate opens, and you can just run straight down the runway, and you can get on a perimeter road from several access roads along that.

So, I asked him to direct his people in that gate, and then they could come on down the perimeter road and stage in that area, and that would probably be the quickest and the easiest way for them to get access.

Q What happens in the event of a power failure? How do you get the gate open?

A I'm not -- I'm not sure what happens. We've never had that problem with one. I guess we would have to -- to go around to one of the gates with a padlock, send somebody around there with a key to unlock it to get them access.

Q That's time-consuming.

A Yes. Yes, it is. But like I say, we've never to my knowledge had any trouble. I think maybe the emergency generators in case of a power failure may take care of those gates. I'm not sure. That's something that we need to look into.

Q Well, have you -- since this accident, we're now seven months past the accident, have -- have you gathered all your troops and all of the surrounding troops that -- that helped out, sat down and done a debrief of the event?

A Yeah. We've talked about it several times, and we're getting to do that -- getting ready to do that more. We have a new ARFF class that's going to start here in about a month or two, and we're looking forward to that to -- all the information we gather from this event, we can incorporate into our new ARFF class and even be able to serve our public even better with this information that we'll glean from here.

Q Have you made any changes?

A We have added six more personnel to the airport. That would put two on each shift, and like I say, we -- we've looked into the DEV Systems, and we're ready to make a proposal on that.

Q So, you now have manning the station six people instead of four?

A Yes, sir.

Q And that's 24-hour coverage?

A Yes, sir.

CHAIRMAN HALL: But you have not had a formal debrief? You haven't pulled everybody in to have a tabletop exercise and formally go over what occurred that evening and --

THE WITNESS: No, sir, not to my knowledge. I'm sure that's coming up pretty shortly.

CHAIRMAN HALL: You might consider that -- that might be very useful, and at the same time, also, you know, have you had an opportunity to request any of the passengers that were -- survived that event for any input from their perspectives that evening?

THE WITNESS: No, sir, we have not had a chance to do that yet.

CHAIRMAN HALL: Well, we'd -- I think we do have a list of the -- the Family Affairs Office has a list, and if you were interested in -- in writing to them or -- and requesting any response or information, we'd be glad to help facilitate that.

THE WITNESS: I would be. I would like to say one word about the passengers. After I got there that night, even after all they had been through, they were calm. They were -- they were stoic. They were brave. They were interested in helping each other. Not only that, they were interested in helping us do our job, and to me, they were the real heroes that night, and I admire them all.

CHAIRMAN HALL: Well, I thought the local newspaper, I'm sure you saw the two special sections they had, and I had a chance over lunch to try to read most of those stories, and it's -- obviously your description is right -- very correct, and there were many, many, many heroes that evening.

THE WITNESS: Yes, sir.

BY MR. FEITH:

Q Chief, have you -- have you had a formal debrief with the airport?

A No, sir, not at this time.

Q Have you expressed in any way, shape or form your concerns about locked gates and -- and things like that?

A I think that's probably going to come up in this next ARFF class here within the next month or two. I'm sure we'll be getting with the airport about -- about some changes that need to take place.

Q Can we afford to wait that long?

A I have not -- some things may have already been discussed. I have -- I am no longer assigned to that particular district that encompasses the airport. The people that are assigned there now, I'm sure, may have already gotten together and discussed a lot of these things, but I'm not privy to that information right now.

CHAIRMAN HALL: Well, we have all the airport folks here and the fire folks, and I'd just suggest to you, it would be very helpful -- I think it would be -- you would find it most useful if you have not already to -- to have a formal meeting and try to bring in everyone that participated in the exercise that evening and go through it and -- and try to learn as much as you can from it, and also it would help you maybe in anticipating and correcting any deficiencies that you might locate as a result of that.

BY MR. FEITH:

Q Chief, are there any advance life support personnel stationed at the airport or are they all -- are they all coming off the airport on to the property from other places?

A Excuse me?

Q Emergency medical service people. Are there any right at the airport or are they all off airport --

A Oh, no, sir. They come from off airport. They -- they do have one unit respond on just normal alerts with us. MEMS or local medical service did a tremendous job that night. They had a supervisor at the -- at the site with me. I was communicating with him face-to-face. They were able to muster together personnel, some 20+ ambulances in what seems like a short time.

We had a MedFlight unit come in and medflight two or three patients out, and we also had about 30+ ambulances present from -- from other areas of our -- surrounding Little Rock. So, I think at one time, we had 51 ambulances there.

So, I just want to take this chance to praise our emergency medical services people. They did an outstanding job for us that night.

Q All right. Well, I appreciate those comments, but just following back, I'm concerned that they're going to locked gates and not having immediate access.

I would think that they should be clued in, too. We have other fire departments, and I would expect that they should be clued in.

CHAIRMAN HALL: And from the federal area, I'd like -- Mr. -- Lyle -- Mr. Reed, if you'd be sure that the local people that work in the tower participate in that exercise, so that if they can agree on some standard terminology in terms of directing equipment, and we -- the Board may have some formal recommendations in that area, but there's no sense in waiting for those.

Has the Board -- has -- has the fire department ever met with the folks in the tower, except you -- they're at the other end of the telephone? Have you ever actually taken your folks up to the tower?

THE WITNESS: Yes, sir. Yes, sir.

CHAIRMAN HALL: Good.

THE WITNESS: I think that's been visited quite frequently.

CHAIRMAN HALL: Good. Okay.

BY MR. FEITH:

Q Just following back, because I -- I think I heard an answer about the command and control. Who is the on-scene commander when all of the off-airport fire departments show up? I mean what -- what is the -- the protocol there?

A That night, I was -- I was not stationed in the district that encompasses the airport. I was in an adjoining district in midtown Little Rock taking care of that area. However, during most normal alerts, the airport -- the chief that's assigned to -- that has the airport assigned under his supervision, he -- he's the only one that will respond to a normal alert.

However, when an incident occurs, and he's going to need some supervisory help, so usually it's the adjoining chief, which I happened to be that night, will go and either assume the on-site command or take over incident command. So, that's how that usually works.

MR. FEITH: Very good. That's all the questions I have, Mr. Chairman.

CHAIRMAN HALL: Very well. Well, thank you, Mr. Tyner, and one thing obviously we'll be inquiring into and would request the airport to look at is how you -- Part 39 presently does not require a family assistance plan, and the handling of where the passengers are going to go, where family members go, are things that I would also suggest at this point that you look at in terms of your exercise and your planning.

Let's -- we'll hold the Little Rock National Airport and the Fire Department for last, so they can question last, and we'll just start back over here with the Federal Aviation Administration with questions for this witness.

MR. STREETER: Yes, sir. Thank you.

INTERVIEW BY PARTIES TO THE HEARING

BY MR. STREETER:

Q Chief, you've covered pretty well the issue of gates there. Just one question. Are there any break-away gates or drive-through gates located on the perimeter fence or do all of them require to be opened?

A I think they all require to be opened either with a lock or a keypad of some sort.

Q Okay. Are you -- are you aware -- as you've been involved in this investigation, are you aware that the differences we have here between the controller who stated that he was told there was some trouble opening the doors on the fire department that night and the firemen who said there was no trouble at all?

Was there or was there not any trouble opening those doors?

A There was not any trouble. The doors opened just like they were supposed to. What happened was that due to the storm, the power was out at the airport, and the emergency generator was on.

The fire-fighter that caught the red phone from the tower and got that information, another fire-fighter had walked in the room beside him, and as he was hanging up the phone, he said, "Gee, I hope the doors open since we're on emergency power", but in fact, they did with no problems. So, there was no delay. They were probably out of the station in less than a minute.

Q Okay. So, those doors -- they're electrically operated then, is that correct, --

A Yes, sir.

Q -- and -- and they are on your emergency power system?

A Yes, sir, and they worked.

MR. FEITH: Can they be opened manually?

THE WITNESS: Yes, they can.

BY MR. STREETER:

Q Now, I need to go back here to your -- because I'm not familiar with your local dispatch procedures here, and I'm trying to sort out something on time.

First of all, your -- your station gets a call on a ring-down line, right?

A Yes, sir.

Q All right. Now, is that line recorded on either end?
A No, sir, I don't think at this time it is.
Q Okay. When -- when the call is received, does the crew have to get themselves dispatched from a central dispatch?
A No. When -- when they get the ring-down from the tower, they go ahead and get in the red ball units. They go ahead and head to the site. As soon as they leave, the ARFF station, they get on another frequency and call the Little Rock 911 Center and tell them that we have an Alert 1 or an Alert 2, position so and so. Then immediately our 911 Center dispatches the off-airport units to come stand by.
Q Okay. So, then your -- your 911 Center is where the exact dispatch times would reside, is that correct? The records?
A Yes, sir. Yes, sir.
Q Okay. Do you happen to know what the official dispatch time was on 911 that night? And the reason I'm asking, sir, is that in the -- in the factual report on the airport emergency response, it says that -- that this occurred at about 2355, and I'm trying to find out if you guys have a better time to pin that down.
A A lot of these times are ambiguous. The times from our 911 Center, the times that -- the tower times, the MEMS times, are all -- were -- were not synchronized on that night, and there's two or three or four minutes' differences in between some of them, but the best times that we have to go by is from our 911 Center.
At about 2358, Red Ball 2 had already gotten the ring-down from the tower. About 2358, he notified our 911 communications that he

needed an off-airport response. So, that happened about 23 --

Q Well, now, let me -- let me stop you there, sir. Now, by that time, since he makes that call on the radio, that means they're already on the apparatus and out of the building, is that correct?

A Yes, sir. They'll be on the way to the site.

Q Okay. Now, is it -- at the 911 facility, is there a time that is logged that it's closer than that or is it just logged to the minute?

A No, sir. This is -- this is the only -- only place that the time is logged is our 911 Center, and then, of course, the tower -- the tower tapes are logged when our units are talking to the tower, and let's say --

Q Right.

A -- the times differ between the tower and our 911 communications.

Q Well, that -- I guess then that -- that goes into my next one, because I was going to ask you if you see -- well, I was going to ask you if you'd read the transcript, but have you seen those times on the tower? How -- how far off are we looking between the different agencies involved?

A Seems like there was like two or three minutes' difference maybe between the two.

Q Hm-hmm.

A I can give you, you know, just a rough estimate of the different times --

Q No.

A -- in sequence.

Q I think it would be more important if you could just provide the information for the record, for the NTSB, because --

A Okay. Yeah. I think they have a list of those --

Q Okay. Very good. In that case, that's all I have, sir. Thank you very much.

A Yes, sir.

CHAIRMAN HALL: The Boeing Commercial Airplane Group?

MR. HINDERBERGER: No questions, sir. Thank you.

CHAIRMAN HALL: American Airlines?

MR. BAKER: Thank you, Mr. Chairman.

BY MR. BAKER:

Q Chief, do I understand at this point in time, we're unable to document exactly the relationship of the ring-down from the tower inasfar as the time goes?

We know when the 911 was because you guys record that in some fashion.

A Right, right.

Q But we don't know exactly when that ring-down activity took place.

A No, sir. That is not recorded, and we don't have an exact time on that, I don't believe.

Q Now, do I also understand you to say that you don't have an understanding of why the tower controller didn't give you more information that he apparently knew; that is, the notion that he had gone down through the mid-part of the airport, when he first dispatched the -- your units?

A No, sir. I can't tell you why all the information was not given us there at the outset, why it was waited until we got to the 4 Right end. I can't explain that.

Q Are you aware, and, if so, do you know what the minimum response time requirement is for Little Rock Airport under the federal rules?

A I think it's -- we should be to the mid-point of the fartherest runway within three minutes. But this did not occur on the airport property. So, I don't -- this particular thing wouldn't apply to this, but if it's on airport property, yes, to the mid-point of the fartherest runway within a three-minute time period, and then I believe the subsequent unit's about four minutes.

Q How many pieces of equipment does the Little Rock Airport Fire Department actually have?

A You're talking about off-airport units?

Q No. The on-airport --

A Oh.

Q The ARFF units.

A We have --

Q How many --

A We have three, sir.

Q Three. How -- how are those -- how is that requirement calculated or determined under the -- the FARs?

A From what I understand, FAR Part 139 requires for Class C airport, 3,000 gallons of water and 400 gallons of foam. We exceed that by one unit. We have 4,500 gallons of water and 600 gallons of foam. So, we're -- we exceed the FAR 139 requirement on that aspect.

Q Do you know why Little Rock is considered a Class C?

A We handle aircraft from a 126 to a 159 feet, I believe, is what that's based on.

Q Now, as I -- just to make sure I'm -- I'm accurate, I understood you to say there were four trained firemen manning three trucks that evening.

A Yes, sir.

Q In your professional opinion, can four men on three trucks conduct any true rescue activities upon arrival at the scene of an accident of the kind of an airplane that we had?

A Not if there's a significant amount of fire present that has to be dealt with first. No, sir. Their primary duty would be fire-fighting, bringing the fire under control so that an escape could be provided for any passengers and for our people that will be coming in and going into the aircraft to assist in rescue. It's imperative that the fire be brought under control first.

Q Do you agree with the concept or the statement that the number of men on duty is not part of the federal requirements for Little Rock Airport?

A I'm aware that they don't have a requirement for manpower. I don't understand why they don't, and there probably should be.

Q And -- and, further, just -- just again for the record, that the ability to conduct rescue operations is not -- not governed under the federal requirements, and that the federal requirements strictly flow out of the ability to respond with flow rates which translates into pieces of equipment and therefore manpower. Did I sum that up about right?

A Yes, sir. I think we're required to -- to fight the fire and to clear one escape pass -- path for the passengers and crew.

Q Now, since you were on the scene, and I know it was a very confused affair, and it was dark and raining, and you don't always think to put all this stuff in -- in your databank, so to speak, but how soon after you and your units arrived would -- would you say that the true rescue of the passengers and crew got started?

A Okay. Our ARFF units got on the scene and extinguished the fire within less than a minute. Within two to three minutes of that, from -- from the accounts that I have read, and the times that I have seen, our rescue people started arriving.

The first one was a heavy rescue unit manned by either five -- anywhere from five to seven people on that night. They are trained to operate this heavy rescue equipment that would be sufficient to extricate anyone from an aircraft of this type.

Shortly after that, other engine companies started arriving with manpower that were able to start rescuing people and triaging people in the field in the area around the aircraft itself, and then from then on, they just kept -- they just kept coming in until we felt we had enough people to handle the situation.

Q Could you put an approximate time after your arrival again before that triage area was up and operating?

A I was -- I was not assigned to the airport that night. I came from the station in Midtown. By the time I got there, the fire was already knocked down and hand lines were in use to put out spot fires under the wings and the fuselage and so forth.

It probably wasn't another -- let's say the Rescue 1 Unit and a couple of engine companies were already there before I got there, and then right after I got there, other units started coming in pretty quickly once we were aware of the situation.

Q Do federal regulations say anything about having one of your personnel, ARFF personnel, also be trained and current in basic emergency medical care?

A Yes, sir. I believe -- I believe that FAR 139 requires that at least one be trained as an emergency medical technician. However, all four of our personnel are, and all of the personnel that were coming in to assist were -- were registered EMTs, also.

Q My understanding and my review of the federal regulations, they use a term "on duty" to suggest the availability of -- of personnel that are trained, and that they be able to respond in a reasonable time.

What's your view of what that reasonable time is in the case of Little Rock and what -- what it should be?

A Our goal in Little Rock is to be anywhere within the city, have an apparatus there within three minutes.

Q Now, very quickly, after your folks got on the scene, it must have become apparent that there were a good number of ambulatory people in the area. They were dazed to one degree or another, again dark, raining.

Was that a problem to -- to your efforts of trying to get at the fire and rescue activities, and what was done about trying to kind of control the area, if anything, and -- and when might the scene have gotten controlled?

A Okay. I'd say the fire was out pretty quickly. We had two buses brought over from the airport station with airport maintenance personnel. We loaded up a lot of the ambulatory people. It was still raining, still some hail and lightening. They were wet. They were cold. We needed to get them to some shelter pretty quickly.

So, a couple of busloads of them were taken over to the ARFF station, and they were handled from there. We sent some more medical units to the ARFF station to handle -- to triage them out some. No one seriously injured was sent over there. Anywhere from minor injuries to moderate injuries ended up over at the ARFF station. They were handled by more medical personnel that we rerouted over to that area, at least the MEM supervisor did it.

The area -- the area was brought under control probably within 30 minutes or so after the -- after our units got there.

Q Now, I want to ask you a theoretical question. You -- you got to the scene. You know what was going on and what was there, the nature of the emergency and the fire.

In your 30 some years of professional experience, if you could have arrived there with your three or four vehicles and as many folks as it would take to do everything you would like to do as a professional fireman, how many people would you have had with you, roughly?

A If I could have had everybody that --

Q Everyone that you --

A -- showed up with me at the very first, --

Q Yes, sir.

A -- not sure on the head count. I think last count, we had 13 of our engine companies, one heavy rescue vehicle, one hazmat vehicle, and nine staff cars and one aerial truck. Those will be manned anywhere from three to four people. Our heavy rescue unit would have five to seven, and our hazmat unit about four.

I haven't gone to the trouble to add it all up yet, but that's about how many were there, and then we had people there from other areas of the community that were providing some mutual aid for us. They sent some of their units to the scene. So, we had -- there is a list somewhere of all of the people that showed up, where they came from and the numbers, but I don't really have it with me right now.

Q One of the things that's always a challenge in -- in disasters of any type is to try to account for everybody. You -- when would you say that was accomplished in this case?

A About 30 minutes into the scene. We had people that were scattered in the hay field area, and we were sending crews out to search for these people and assigning them different quadrants to look for the people that were scattered out.

I was kind of worried at first because we were finding people a considerable distance from the airplane itself, out past a swampy area, between there and the river, and I thought -- thought that we may have people scattered out over a very wide area, and however, in talking to some of the people that were out there, we found out later that most of those people had walked out there to get away from the burning airplane because they were afraid it was going to explode, had some people that were injured out in those areas, but come to find out they were not thrown there. They were carried or drug there by other passengers to get them away from the aircraft.

So, once -- once we determined that, we -- we did a line abreast search maybe 50 to a hundred feet on each side of the aircraft, from the aircraft all the way back to the Arkansas River, arm to arm, line abreast, to search the area for anyone we may have missed, didn't find anyone on that pass, and we were pretty confident that we had found all of the injured.

However, just to be sure, when daybreak came, and we could see better, we went ahead and did the same procedure again, and we searched that same area the same way and -- and didn't find anyone else. So, at that point, we were -- we were pretty sure that we had accounted for all the victims.

Q Could you briefly describe the concept of Alert 1, Alert 2 and Alert 3, and what that means to someone who doesn't understand it very well?

A Well, I understand it. Alert 1, you may have an aircraft coming in that may have some sort of a warning light on in the cockpit to indicate some minor problem that's really not -- really not going to be in any danger of the aircraft landing, but they want us to be aware of it anyway. So, they'll go ahead and call the tower, tower will call over the ring-down phone and say we've got, you know, a plane with this warning light on or a certain problem.

At that point, an Alert 1, the crash units stand by at the station. They're just aware that there could be a problem. There's not yet, but they're just standing by. They notify the off-airport companies through our 911 communications that there's an Alert 1. They do not respond. From that point, they're on standby in case it progresses.

Alert 2 would indicate they may have a light on in the cockpit that indicates a little more severe problem, a landing gear that's not locking or so forth. That would move it up to an Alert 2.

That's when the crash units would go out to their pre-assigned positions. They would call our 911 communications and have our off-airport companies respond on that, and they would go to their pre-determined positions and standby and wait on this aircraft to land to make sure that he in fact didn't have any problems.

An Alert 3 means that an incident has occurred as in the case of 1420.

Q Was the term "Alert 3" used that evening in fire department communications, and, second, specifically from the control tower to you guys?

A Yes, sir. When our red ball units reached the end of the runway, the 2-2 Left end, and saw the plane burning, one of the people in the -- in our crash units, he repeated that three different times to the tower and also to our communications, that this would in fact be an Alert 3. I think he repeated it three times, and at that time, everyone was put on alert, and -- and -- and the airport plan was put in -- put in motion at that time.

Q Is that the first time that term "Alert 3" was used that evening?

A Yes, sir, to my knowledge.

Q Are those definitions written down anywhere?

A Yes, sir.

Q Is there a formal agreement and a transfer of those written definitions between the Little Rock Fire Department and the control tower?

A Yes, sir, I believe there is.

Q Did the control tower operator use the term "Alert 3" at any time?

A In reviewing the -- the transcripts, I can't remember him saying that, sir. I don't think so.

Q Thank you very much.

MR. BAKER: Mr. Chairman, that's all we have.

CHAIRMAN HALL: Mr. Tyner, before we continue, your -- your plan -- let me inject here. I assume, Mr. Baker, that there were a number of people waiting there at the terminal for passengers arriving on this flight.

Did you have any plan in place for what you did with the passengers that were -- that were not taken to the hospital?

THE WITNESS: No, sir. That is in the airport plan, but the -- the air -- the airport itself usually takes care of that aspect of it. So, I'm not aware of what plans were made to do with them after they left the --

CHAIRMAN HALL: But you were in charge of that -- you were the incident commander?

THE WITNESS: The site commander. Yes, sir. The incident commander was at the ARFF station itself.

CHAIRMAN HALL: Right.

THE WITNESS: I was the operations officer there at the scene.

CHAIRMAN HALL: So, you did not have a plan to -- on what to do with passengers that were not injured?

THE WITNESS: No, sir. Once they left the scene on the buses, they -- the buses are driven by airport personnel people, and they -- they have pre-determined locations where to send these people.

However, in all fairness, I think the weather played a tremendous factor that night. Those people needed some shelter. They needed to get out of that field quick. The crash station was close. They knew there was someone there, and that's -- that's probably one reason why they ended up at the -- at the ARFF station.

CHAIRMAN HALL: Were you aware of any plan for the families that might have been -- or individuals waiting for passengers on that flight?

THE WITNESS: No, sir.

CHAIRMAN HALL: Allied Pilots Association?

MR. ZWINGLE: Thank you.

BY MR. ZWINGLE:

Q Chief Tyner, is it standard procedure for your ARFF unit to -- in response to -- in a search mode response to send all three apparatus to the same location rather than dispersing them?

A Yes, sir. They are trained to work as a team, and if they did come up on something, and one of the units got in trouble, there would not be another unit there to cover them.

Also on that night, visibility was so poor, they were afraid if they got separated, that they may in fact collide with each other.

Q Understand. When was the last airport emergency preparedness exercise conducted?

A That was in 1996.

Q Were -- can I assume -- well, were off-duty personnel required to participate in that?

A Yes, sir. I was -- as a matter of fact, I was off-duty that day, but I came in and participated, yes.

Q Do you happen to know if any of the fire-fighters involved in the response were hired since that -- that drill or did not participate?

A Were hired since that drill?

Q Or did not participate for some reason.

A Yes, sir. I'm sure there were some.

Q Okay. Did the Little Rock Tower participate in that exercise?

A Yes, sir.

Q Okay. Do you know of any exercises or drills that are initiated by the tower?

A No, sir. I'm not aware of --

Q In other words, drills scheduled by your department, but the actual notification is initiated from the tower using the crash phone?

A Right.

Q And you're not aware of that?

A No. No, sir.

Q Okay. May I assume or am I correct to assume that the dispatchers or call-takers in your 911 Center are trained to interrogate callers? In other words, to determine location, type of emergency, etc.?

A Yes, sir, I believe they are, yes.

Q Are your fire-fighters who man the -- who answer the phone, the crash phone --if that's not the correct term, I apologize. In the fire station, are they trained to interrogate?

A No, sir. They usually just follow directions that they are given by the tower.

Q Is there any sort of checklist by the phone that they could use in an interrogation or clarification of a call?

A Not that I know of, sir.

Q Is there a portable radio available to each apparatus?

A Yes, sir.

Q To what extent does the emergency response plan depend on the Little Rock Fire Department?

A To what extent? I would say we play a fairly major role in it. Every -- every -- every participant is important, but I would say ours is one of the most major ones.

Q Do your off-airport emergency response units conduct airport-specific training?

A Yes, sir.

Q They do?

A Yes, sir.

Q And this training includes airraft familiarization and airport layouts?

A As a matter of fact, all of our off-airport response companies are required to go to the ARFF training and participate in the hot drill once a year.

Q Thank you very much, Chief.

A Yes, sir.

Q No further questions, sir.

CHAIRMAN HALL: Mr. Reed, I don't have Mr. Roman here. How often are they supposed to -- under Part 39, how often are they supposed to have exercises? I thought it was every two years, is that correct or incorrect?

MR. STREETER: We're gioog to find out in just a moment.

CHAIRMAN HALL: Very well.

(Pause)

MR. STREETER: The -- the hot -- the hot fire drills are once a year, the annual tests that our airport inspectors do are once a year, and it's once every three years for the -- the major disaster exercises.

CHAIRMAN HALL: Okay. And I assume you have the dates. I guess we have the dates --

MR. STREETER: Well, I don't have them, but we --

CHAIRMAN HALL: -- for the record.

MR. SWEEDLER: We can get them, yes.

CHAIRMAN HALL: Very well. The Association of Professional Flight Attendants?

MS. LORD-JONES: Yes.

BY MS. LORD-JONES:

Q Chief Tyner, just assuming that the aircraft had been equipped with an EOT or a GPS system, and assuming that your people were trained in that equipment, in your professional opinion, do you believe that your response time may have been reduced in this accident?

A Sure. I believe that could have helped a great deal.

Q Thank you.

CHAIRMAN HALL: Okay. The National Weather Service?

MR. KUESSNER: No questions, sir.

CHAIRMAN HALL: Little Rock National Airport?

MS. SCHWARTZ: No questions, Mr. Chairman.

CHAIRMAN HALL: Little Rock Fire Department?

MR. CANTRELL: No questions, sir. Thank you.

CHAIRMAN HALL: Okay. Mr. Sweedler?

MR. SWEEDLER: No questions, Mr. Chairman.

CHAIRMAN HALL: Mr. Berman?

INTERVIEW BY THE BOARD OF INQUIRY

BY MR. BERMAN:

Q Sir, can you estimate how long it would have taken you to open your station doors manually if you'd had to do so?

A No, sir. I have never had to do that. I don't think it's that time-consuming, though, to my knowledge.

Q It sounds like a good thing maybe to figure out, but --

A Yes.

CHAIRMAN HALL: Mr. Clark?

MR. CLARK: I have no questions.

CHAIRMAN HALL: Well, let me make two observations, if I could, and these are personal observations, and obviously the Board will speak in a formal recommendations to this subject later. Bad seeing yourself on tv. You can see where my hair's sticking up.

I want to compliment everybody that responded, and I have read some of the stories, and we have -- have a number of statements that have been taken from the passengers that are part of the Survival Factors Group Factual Report that is also going to be considered as part of the investigation, and I read the paper today, and -- and it's -- there were obviously, as I said, many people that were heroes that were there that evening.

On the other side, let me say that as taxpayers, we pay through local, state and federal taxes to ensure that we have proper response services at the airport for the very rare event that this is, and those services are dependent on close coordination between all the various elements that are involved, and I do not see that close coordination here in Little Rock. That's a personal observation, and I'll take advantage of having the Mayor and the airport manager and the police chief here.

But I -- fire chief. But I would tell Mr. Reed, I would like the FAA to work very closely with the local people to come together and have a serious look at what took place that evening of June 1st, 1999, to talk to the -- and I apologize to the families.

I -- the survivors. We are very reluctant sometimes to ask witnesses to come forward when we have a number of survivors because trying to relive an experience like that is not anything we feel that we want to put anyone through.

But if there are any thoughts that you have for that evening, there are some serious things that need to be considered in Part 39, Mr. Reed, and I hope the Board will address this. I can't speak for the other board members, and the investigation report is not completed, but there is improvements that -- that need to be made.

Expensive -- there's expensive equipment that's funded by the -- by the Federal Aviation Administration, the airport and others, and I would -- there are a lot of good folks here. I couldn't -- the folks at the airport and the fire department, everywhere Greg and I visited, everybody's very polite and very nice.

But you never know when something like this might occur again, and -- and -- and when you do have an event like this, that's the time to really try to learn and try to correct any deficiencies and -- and improve -- improve what may already be a pretty good system, but there's always -- I've never seen people go through that exercise that they don't learn things and take and improve the system, and I -- I just leave that as a -- as a -- as a personal observation and a request for you to consider.

Now, we have --Mr. -- Chief Tyner, let me offer you the opportunity as we have all of the witnesses -- you -- you lived through this event and were very involved in it.

Is there any -- any other closing comments or thoughts that you want to provide with -- for the Board on this occasion?

THE WITNESS: Just to say that once again, no one on that night wanted to find that aircraft any quicker than those four men there at the ARFF station. I'll guarantee you, and they did the best they could with the information that they had. They had a tremendous amount of pressure on them, but they kept thinking, they kept going to the next step, till they located the aircraft and extinguished the fire, and I'd just like to say that I appreciate you letting us take part in this hearing.

It's been very informative. We're looking forward to taking what information we gleaned from this and incorporating that into our training programs and becoming better servants to the citizens that pay our salaries, and again let me say one more time, my hat's off to the passengers that night. They're heroes. I respect each and every one of them, and I'm inspired by reading their stories.

Thank you, sir.

CHAIRMAN HALL: Well, thank you, Chief, and there's no question what -- that I know what was in the heart of those fire-fighters that evening, but we also have to look at the cold reality of how long that response took, and that's what needs to be, I think, looked at very factually and by everyone here and see how -- if maybe you all can come up with some real improvements and set a model for the nation.

You are excused, Chief.

(Whereupon, the witness was excused.)

CHAIRMAN HALL: I'd like to -- we're -- I have a brief closing statement that I'm going to read that is required, but I'd like to give the parties an opportunity for any closing remarks, and if any of the parties would like to make closing remarks, please let me know.

Mr. Baker?

MR. BAKER: Thank you very much, Mr. Chairman.

Ladies and gentlemen, this hearing was convened as an important step in the investigative process of Flight 1420. During the last few days, we've heard witnesses talk about procedures, flight training, air traffic control, aircraft systems, radar and weather.

The technical evidence, if you will, that is critical to achieving our common goal of preventing similar accidents in the future. This intense focus on the evidence was the hearing's purpose, but it is by necessity a somewhat clinical and impersonal exercise.

It is thus important to note that the people who were aboard Flight 1420 and the families of those who died are never far from our thoughts. They have shared an experience that is difficult for anyone who has not shared it to fully understand. They came here personally and have listened extremely patiently to these proceedings, and we appreciate their intense interest in identifying the causes of this accident.

Further, the participation and hard work that each party has contributed shows that all of us in the aviation industry share that interest, and as I have said before publicly, all of us in the American Airlines family are truly sorry that it occurred.

Thank you, Mr. Chairman.

CHAIRMAN HALL: Thank you, Mr. Baker.

Mr. Reed? Boeing? Pilots? Flight Attendants? Weather Service? National Airport? Fire Department?

MR. ZWINGLE: Mr. Chairman, --

CHAIRMAN HALL: Yes, sir.

MR. ZWINGLE: -- I'll speak for the Allied Pilots Association, as I have.

CHAIRMAN HALL: There's no closing statement required. I just --

MR. ZWNGLE: No. That's --

CHAIRMAN HALL: I just wanted to give you all an opportunity if you wanted to.

MR. ZWINGLE: I do want you to know that each -- each gentleman who sat at this table was a pilot -- is a pilot for American Airlines. We debriefed every evening, and we learned a lot, and I'm just sorry that this had to be the venue for that learning experience.

CHAIRMAN HALL: Thank you for your participation.

Any other comments?

MR. CANTRELL: Mr. Chairman, we have the number for the Family Affairs Program. We'll be contacting those people very shortly after the completion of the hearing.

CHAIRMAN HALL: Thank you, Chief. I appreciate that very much.

Do any of the Board of Inquiry -- Mr. Feith, you're the inspector -- investigator-in-charge of this. Do you or any of the Technical staff have brief closing comments?

MR. FEITH: I think -- was that enough?

CHAIRMAN HALL: That's about too much. No, no. Go ahead.

MR. FEITH: Well, first off, I think I speak for those of us that are still here and those of us that have left. As always, being the investigator-in-charge of an accident is never easy, and it's managing personalities, not only the people that I work with but those that I don't work with every day.

While we all have a professional relationship under the worst of circumstances which we do here today and any time there's an accident, I appreciate the business friendships that I have with -- with most of you that I've had the opportunity to work with, and I know that the rest of my staff has, too, and I appreciate the confidence that the Chairman and at least our supervisors show in our abilities to put something like this together.

It's probably the hardest part of the investigative process, is bringing witnesses together, putting them up on the stand and -- and putting them before an audience and trying to get information that in the long run will benefit us and aviation safety.

So, I just want to say that I appreciate the cooperation that everyone has given us from the parties. I show a lot of respect to you, even though I take a lot of abuse from you, but I do appreciate it, and I want to continue this working relationship as does everyone else that -- that works with you.

So, again, thank you very much, and thank you to the City of Little Rock for taking care of us while we've been here.

CHAIRMAN HALL: Do any of the members of the Board of Inquiry have a closing statement?

MR. SWEEDLER: Just a quick thought. Participating in -- in a hearing of this nature is always a sad and -- and -- and difficult exercise, but we know from past experience that what we learn from hearings like this really makes a -- a -- a definite difference in improving aviation safety, and I think it's worth the effort to do that.

CHAIRMAN HALL: Thank you very much. Before I read this statement, I just want to thank the Mayor for the coffee, for the friendship, the folks from the airport and fire department, family members I've had a chance to visit with. I think Mr. Baker said it best in terms of our thoughts and prayers continue to be with -- with each one of you all.

We want to thank and acknowledge obviously everyone here with the City of Little Rock and this area and community.

Being from Tennessee, I know sometimes people come from

Washington, and they're not good neighbors. I hope that our folks that have come here, Mr. Feith, our investigators, the folks that have come here, have been good neighbors to you all while we've been here, and I assure you that we will work very hard to conclude this investigation in a timely fashion and provide the report and the recommendations that you as taxpayers fund and pay for through your Federal Government.

With the last witness having been heard, this concludes this phase of the Safety Board's investigation.

In closing, I want to emphasize that this investigation will remain open to receive at any time new and pertinent information concerning the issues presented.

The Board may at its discretion again reopen the hearing in order that such information may be made part of the public record.

The Board welcomes any information or recommendations from the parties or the public which may assist it in efforts to ensure the safe operation of commercial aircraft. Any such recommendations should be sent to the National Transportation Safety Board, Washington, D.C. 20594, to the attention of Mr. Gregory Feith. Normally, they should be received 30 days after the receipt of the transcript of the hearing, of this hearing.

All the evidence developed in this investigation and hearing and all recommendations received within the specified time frame will be presented and evaluated, and the final report on American Airlines Flight 1420 in which the National Transportation Safety Board's determination of the probable cause will be stated.

I might point out that transcripts, information and the simulation from this hearing are available at the Board's web site, www.ntsb.gov.

On behalf of the National Transportation Safety Board, I want to again thank the parties for their cooperation not only during this proceeding but also throughout the entire investigation of this accident.

Also, I want to express sincere appreciation to all those groups, persons, corporations and agencies who have provided their talents so willingly throughout this hearing.

I would also like to recognize the news media who has spent every hour, most of them, with us in covering this event and doing a very good job of reporting the events that took place here to the nation.

The record of the investigations, including the transcript of the hearing, and all exhibits entered into the record will become part of the Safety Board's public docket on this accident and will be available for inspection at the Board's Washington Office.

Anyone wanting to purchase a transcript, including the parties to the investigation, may contact the court reporter directly.

I now declare this hearing to be in recess indefinitely.

(Whereupon, at 9:00 p.m., the hearing was adjourned sine die.)