MEMORANDUM

TO: Thomas E. Haueter
Deputy Director
Office of Aviation Safety
National Transportation Safety Board

FROM: American Airlines, Inc.

DATE: June 25, 2001

RE: AA Flight 1420
NTSB# DCA99MA060

Based upon discussions at the Technical Review on May 9, 2001, as well as other discussions with members of the NTSB staff, it is American's understanding that at least a draft of the final report in this accident investigation has been completed. Accordingly, American has chosen not to file a traditional ICAO-style submission. Rather, to provide input to the NTSB in the most useful format under the circumstances, American is submitting via this memorandum its views regarding the results of the accident investigation.

Executive Summary

On June 1, 1999, at approximately 2350:20 CDT,[1] Flight 1420 landed at Little Rock/Adams Field (LIT) on Runway 4R in the designated touchdown zone, slightly right of the runway centerline. Unfortunately, the aircraft was unable to stop and departed the end of the runway, traveled down a 25-foot rip-rap slope at the end of the 450-foot runway safety area, and struck a non-frangible approach light stanchion. The captain and 10 passengers sustained fatal injuries. The aircraft was destroyed.

The probable cause of the accident was the non-deployment of the aircraft's ground spoilers on touchdown. As the testimony at the public hearing indicated, and as the NTSB's Aircraft Performance Study verified, if the ground spoilers had deployed upon landing, the aircraft would have stopped on the runway and the accident would have been prevented.

The flight crew inadvertently failed to arm the autospoiler system due to distractions associated with an increase in cockpit workload that interrupted the crew's

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[1] All times noted in this memorandum are expressed as Central Daylight Savings Time, using a 24-hour clock.

performance of the "Before Landing" checklist. After landing, the flight crew did not recognize that the ground spoilers had not deployed, so they did not deploy them manually.

Factors contributing to the accident were the weather conditions at LIT and the flight crew's inadvertent failure to follow all of American's policies and procedures. The design of the LIT Runway 4R safety area and the non-frangibility of the approach light stanchion that the aircraft struck after it departed the runway contributed to the severity of the accident. Other events not directly related to the non-deployment of the ground spoilers should not be considered causal or contributing factors, in view of the finding in the Aircraft Performance Study that the aircraft would have stopped on the runway uneventfully if the ground spoilers had deployed on landing.

Analysis

1. Non-deployment of the ground spoilers on landing was the probable cause of the accident. The aircraft would have stopped on the runway if the ground spoilers had deployed.

The NTSB's Aircraft Performance Study found that "the lack of spoiler deployment on touchdown [was] the most significant factor in both the handling problems on the runway and the airplane's poor braking performance."

In particular, observing that "the effectiveness of the brakes, and the resulting deceleration and stopping distance, is critically dependent on spoiler deflection," the Aircraft Performance Study found that the aircraft would have stopped about 700 feet from the end of the runway if the spoilers had been deployed and reverse thrust of 1.3 EPR had been used (assuming all other parameters from the Flight 1420 rollout, including the runway conditions and the braking profile, remained the same). Spoiler non-deployment was the determinative factor in the flight crew's inability to stop the aircraft on the runway, as well as the flight crew's difficulty in maintaining directional control after landing.

a. The ground spoilers did not deploy on touchdown because the autospoiler system was not armed by the flight crew. The flight crew inadvertently failed to arm the autospoiler system due to distractions associated with an increase in cockpit workload that interrupted the crew's performance of the "Before Landing" checklist.

In preparation for landing, First Officer Origel lowered the landing gear as directed by Captain Buschmann and as required by the "Before Landing" checklist. After landing gear extension, the next item on the "Before Landing" checklist is arming the autospoiler system; however, the system is not supposed to be armed until the landing gear is down and locked. While First Officer Origel waited for the landing gear to cycle into the down and locked position (which is indicated in the cockpit by three green annunciator lights), he was distracted from arming the autospoiler system by an

increase in cockpit workload, which included receiving and responding to numerous ATC reports, analyzing reported changes in RVR with Captain Buschmann, lowering flaps for landing, and monitoring the altitude to make the 1,000-foot callout. During that period, tasks required the flight crew's prompt attention as they arose, and the subject matter of the tasks presented to them quickly changed from one topic to another. By the time cockpit workload demands leveled off, First Officer Origel's normal habit pattern associated with arming the spoilers and completing the "Before Landing" checklist had been broken. Since there is no aural warning or annunciator light on the MD-80 to alert the crew that the autospoiler system is not armed in the landing configuration, the inadvertent omission to arm the autospoiler system during the "Before Landing" checklist went unnoticed.

Sometimes described in the human factors literature as an "action-slip," the effect of habit-pattern interruption in the context of checklist performance has been examined in a report prepared by Asaf Degani and Earl L. Wiener for the National Aeronautics and Space Administration ("NASA") entitled Human Factors of Flight-Deck Checklists: The Normal Checklist (NASA Contractor Report No. 177549). In that report, Degani and Wiener pointed out that "[d]istractions and interruptions can 'break' the checklist process and may result in a checklist error or omission." They also observed:

> Omission of checklist items sometimes occurs when an item that could not be completed in sequence . . . is deferred by the crew to be accomplished later on. But since the traditional paper checklist has no means of prompting the pilot about such unaccomplished items, the deferred item is stored in the pilot's short-term memory. However, due to the limitations of this memory, coupled with time constraints, and the vulnerability of the crew to distracting events, the likelihood of this item being omitted is relatively high.

This particular observation by Degani and Wiener is directed specifically toward errors involving performance of paper checklists. American Airlines is one of the few major airlines to use a mechanical checklist (for the "Takeoff" and "Before Landing" checklists) in the cockpit. A mechanical checklist shows non-accomplishment of a deferred checklist item, and, therefore, is not as susceptible as a paper checklist to an action-slip resulting from habit-pattern interruption. Nevertheless, as demonstrated by the survey conducted at a U.S. cargo carrier (discussed immediately below), the possibility of an action-slip remains a concern even in connection with mechanical checklists.

In the NTSB investigation, it was learned that the potential for an action-slip in the DC-9/MD-80 "Before Landing" checklist was documented in a survey at a United States cargo carrier after one of its aircraft experienced a landing incident involving spoiler non-deployment. The survey found that flight crews performing the "Before Landing" checklist sometimes lowered the landing gear but then skipped over the next checklist item, arming the autospoiler system, as they waited for the landing gear to cycle into the down and locked position. Before the "gear door open" light went out, indicating that the landing gear was extended and the gear doors were closed, flight

crews were observed proceeding with extending landing flaps, which follows autospoiler system arming on the "Before Landing" checklist. It was found that flight crews then occasionally forgot to go back to arm the autospoiler system to close out all items on the checklist.

b. After landing, the flight crew did not recognize that the ground spoilers had not deployed, so they did not deploy them manually.

The aircraft began to slide immediately after it touched down. As the aircraft traveled down the runway, first sliding to the right and then back to the left, Captain Buschmann and First Officer Origel were undoubtedly focused on maintaining directional control and stopping the aircraft.[2] Consequently, they did not notice that the ground spoilers had not deployed.[3] (On the MD-80, there is no aural warning or annunciator light to alert the crew if the ground spoilers do not deploy on touchdown.) Had the crew realized the ground spoilers were not deployed, they certainly would have deployed them manually.

c. American has made appropriate revisions to its procedures for ground spoiler deployment.

American has revised its "Before Landing" checklist to reduce the possibility of the autospoiler system inadvertently not being armed. Under the revised procedure, the pilot-not-flying is required to call out each item on the mechanical "Before Landing" checklist, visually verify that each item has been accomplished, call out the appropriate response, and move the corresponding switch on the mechanical checklist. The pilot flying is to verify and make a verbal response for altimeters, flight instruments and bugs, landing gear, spoiler lever, and flaps and slats. In conjunction with the 1,000-foot callout by the pilot-not-flying, both pilots are to verify visually that all items on the mechanical checklist have been closed out, and the pilot-not-flying is to call out, "Before Landing Checklist Complete." By directly involving both pilots in completing the "Before Landing" checklist and in double-checking its completion, this revised procedure incorporates redundancy that reduces the possibility that arming the autospoiler system could be inadvertently omitted.

American also now requires that the captain arm the autospoiler system on every flight, regardless of who is flying the aircraft. Placing the responsibility for arming the autospoiler system with the captain, rather than the pilot-not-flying, adds a further

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[2] At the time, the flight crew probably attributed the braking and directional control problems they experienced to hydroplaning. The Aircraft Performance Study pointed out that "with the spoilers down the braking performance above 140 knots is no better than that achieved when hydroplaning; not because the runway surface conditions are lowering the friction coefficient, but because the lift from the wings is preventing the gear from putting much force on the runway."

[3] First Officer Origel's ability to notice the non-deployment of the ground spoilers also may have been affected by the position of the spoiler lever in the cockpit (on the far side of the center pedestal, left of the throttle quadrant), the lighting in the cockpit, and his awkward seating position (caused by the aircraft's travel to the right).

measure of reliability to the performance of the "Before Landing" checklist. Also, because the spoiler lever is located closer to the captain, it is ergonomically easier for him to arm the autospoiler system.

In addition, American has revised its procedures for monitoring spoiler deployment after touchdown. American's procedures have always required both pilots to check that the spoiler lever moves back to the full aft (extended) position after touchdown. Under the revised procedures, both pilots are still required to check for spoiler deployment on touchdown, but now the pilot-not-flying is responsible for calling out, "Deployed" or "No spoilers" as appropriate, and, as always, the captain (regardless of who is landing the aircraft) is to deploy the spoilers manually if necessary.[4]

2. The flight crew's decisions to commence the flight, to execute the approach and to land did not cause the accident.

In the course of the investigation, attention has been given to certain of the flight crew's decisions to commence the flight, to execute the approach, and to land at LIT. In assessing flight crew decision-making during Flight 1420, it must be recognized that the aircraft landed on the runway, within the designated touchdown zone, close to the runway centerline, and essentially on speed. Even more importantly, it must be recognized that the Aircraft Performance Study found that the aircraft would have stopped on the runway, without incident, if the ground spoilers had deployed on landing. Since no accident would have occurred if the ground spoilers had deployed, it is evident that the flight crew's decisions in connection with departure, approach, and landing were not causal factors.

On the morning of the accident, Captain Buschmann and First Officer Origel began a 3-day trip sequence together. Their third and final flight segment of the day was Flight 1420, which was scheduled to depart DFW for LIT at 2028. Noting that contractual duty limitations would not allow them to conduct Flight 1420 if the departure were delayed to await the arrival of the scheduled aircraft, the flight crew worked with the dispatcher to arrange for N215AA to be substituted as the aircraft for Flight 1420. While at DFW, Captain Buschmann called his wife, who told NTSB investigators that he did not sound tired or anxious. First Officer Origel said that he and Captain Buschmann "felt okay and were not tired."

At DFW, Captain Buschmann obtained the flight release documents for Flight 1420, which included all applicable weather information. Before departing DFW, the flight crew discussed the weather conditions and forecasts and reviewed weather imagery for the planned route of flight. They also discussed the option of diverting to alternate airports if conditions precluded landing at LIT. At 2239, prior to pushback from the gate, the dispatcher sent the flight crew a SIGMEC update via the ARINC Communication Addressing and Reporting System ("ACARS"). Thus, at the time of departure, the dispatcher and the flight crew had received and analyzed all of the LIT

[4] American has made a number of manual revisions relating to matters discussed at the public hearing. Pertinent manual revisions are summarized in the table attached to this memorandum.

weather information that was reasonably available, and nothing in that information precluded Flight 1420 from being dispatched to LIT. However, if weather were to interfere with the flight, the flight crew was aware of their options to divert to alternate airports. The flight crew's decision to depart DFW to LIT was sound and appropriate.

Flight 1420 departed at 2240. At 2254, as a follow-up to the SIGMEC update provided at 2239, the dispatcher sent an ACARS message informing the flight crew that there were thunderstorms moving east-northeast towards LIT that might be a factor for their arrival. The dispatcher reported that there was "a large slot to LIT" with thunderstorms "on the left and right and LIT is in the clear," which the dispatcher described as "sort of like a bowling alley approach." The dispatcher suggested that they expedite their arrival. Captain Buschmann and First Officer Origel discussed this message and interpreted it to mean that they should not accept any undue ATC delays en route to LIT. They did not feel, based upon this message, that it was necessary to alter their flight plan or increase their speed en route to LIT. This message concerning conditions at LIT was helpful and descriptive to the flight crew and confirmed that the weather in LIT was above all required approach and landing minimums.[5]

At 2301 and 2304, the Fort Worth Air Traffic Control Center ("ARTCC") broadcast Convective SIGMET 15C, which forecast possible severe thunderstorms over an area that included LIT on its eastern edge. SIGMET 15C did not signify to the flight crew a major new development in the weather conditions at LIT, as it was generally consistent with the ACARS message they had received from the dispatcher.

During the en route portion of the flight, the crew obtained LIT Automatic Terminal Information System ("ATIS") report (Quebec), which indicated that Runway 22L was the active runway for arrivals at LIT. ATIS did not indicate that thunderstorms were then affecting arrivals at LIT. During the en route segment, Flight 1420 operated in visual meteorological conditions, which likely influenced the flight crew to believe that the potential adverse weather referenced in the ACARS message and in SIGMET 15C would not be a threat during the short time required to reach LIT.

At 2329, observing that the flight might "get a little bumpy," Captain Buschmann told the flight attendants to finish their cabin beverage service quickly so that everyone could take their seats during the approach. This was appropriate action for a captain taking proper precautions for the safety of his passengers and crew.

From approximately 80 miles away, the flight crew could see the lights of Little Rock. At about 2337:17, First Officer Origel stated that he had visual contact with the airport, which was then about 20 miles away. About a minute later, Captain Buschmann stated that he also could see LIT. The flight crew's ability to see LIT at this point in the

[5] Before sending this message, the dispatcher ran a flight-following program overlaying the route and weather. The dispatcher's flight-following also included monitoring the Aircraft Situation Display ("ASD"), radar composites, and the National Lightning Detection Network ("NLDN") data regarding lightning strikes. In describing his flight-following to the NTSB Meteorology Group, the dispatcher stated that he concluded that Flight 1420 would reach LIT safely before thunderstorms moved into the area.

flight is significant. While they were aware of evolving weather, their ability to see the airport from 20 miles away indicated to them that they were sufficiently ahead of any approaching adverse weather to execute an uneventful approach and landing. The crew's belief that a landing at LIT would not be adversely affected by any evolving weather was reinforced as they continued to maintain visual contact with LIT while they approached the Little Rock area.

During the approach and descent, the crew frequently discussed weather conditions with the LIT tower controller and with each other. They specifically addressed crosswind limits for landing on wet and dry runways, as well as RVR limits for approach and landing. The crew worked hard to analyze the weather conditions and their options. Based on their assessment of the situation, they believed that an approach and landing could be executed safely.

Observing at 2339:42 that the wind direction reported by the LIT tower controller would result in a tailwind for landing on Runway 22L, Captain Buschmann requested that First Officer Origel get clearance to land on Runway 4 to have a headwind. First Officer Origel then contacted the LIT tower controller, requesting and receiving clearance to land on Runway 4R. The flight crew's decision to request Runway 4 for landing shows that the flight crew was willing to change their plan to adapt to changing conditions. It also shows that they were not rushing to land at LIT to beat the arrival of a thunderstorm. (At that point in the arrival sequence, if the flight crew had been hurrying to land before a thunderstorm reached LIT, they would not have delayed their landing by turning back to the southwest to intercept the Runway 4R approach course.) Indeed, given that the change in runways would result in a landing delay, the flight crew's request to change runways confirms that they continued to believe that the evolving weather situation would not adversely affect their approach and landing.

After receiving initial vectors to the Runway 4R ILS approach course, the flight crew conducted an approach briefing for Runway 4R. Between 2340:36 and 2342:16, the flight crew briefed the runway in use, final approach course, minimum safe altitude, ILS frequency, decision altitude, glideslope intercept altitude, and missed approach procedure. Because of the proximity of the aircraft to LIT when the runway change occurred, the approach briefing had to be completed in segments rather than in the usual manner that it would be performed at altitude, but the flight crew briefed safety-of-flight approach information that had changed as a result of the change in landing runways. The manner in which the flight crew performed the approach briefing for Runway 4R did not affect the outcome of the landing.

First Officer Origel continued to retain visual contact with the field, except when he reported at 2344:30 that there was a cloud between the aircraft and the runway. Although the flight crew saw some lightning to the west and northwest, they obviously considered the lightning sufficiently distant to pose no threat to their approach. Also, Flight 1420 had encountered little or no precipitation up to this time. All of these factors

continued to reinforce the flight crew's impression that the evolving weather was located to the west of their intended flight path and would not affect landing.[6]

When the aircraft was about 4 or 5 miles from the airport, the LIT ATC supervisor noted the aircraft on the radar in the TRACON. He saw the weather on the radar but observed nothing that would affect Flight 1420's approach. This assessment from the LIT ATC supervisor is consistent with the flight crew's perceptions at the time. Also consistent were the LIT tower controller's communications with Flight 1420 during the approach. The LIT tower controller's communications never indicated to the flight crew that he expected the landing to be anything other than uneventful, which provided further reinforcement to the flight crew's assessment of the weather situation.

At 2347:34, the flight crew began to configure the aircraft for landing. First Officer Origel lowered the landing gear at 2347:46 as directed by Captain Buschmann and as required by the "Before Landing" checklist. The CVR did not record a subsequent verbal acknowledgment that the autospoiler system was armed, nor did it record sounds characteristically associated with the mechanical action of autospoiler system arming. As explained above, First Officer Origel was distracted from completing the "Before Landing" checklist by an increase in cockpit workload, including receiving and responding to a number of ATC communications, evaluating the weather conditions reported by the LIT tower controller, lowering the flaps for landing, and monitoring the altitude for the 1,000-foot callout.

One of the ATC communications that contributed to the increase in cockpit workload was the LIT tower controller's report at 2348:12 that the Runway 4R RVR was 1,600 feet. Captain Buschmann and First Officer Origel discussed whether the reduction in RVR would allow them to continue the approach, and they concluded that they could continue because the aircraft was already established on the final approach segment.[7] Also, First Officer Origel has said that he had visual contact with the runway environment, which is consistent with the flight visibility they experienced during virtually all of the earlier portions of the approach. Furthermore, up to that point, they had not encountered heavy precipitation; in fact, the precipitation up to that time had been insufficient even to require the activation of the windshield wipers.[8]

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[6] Further information regarding the weather conditions appears in the enclosed Weather Addendum.

[7] FAR § 121.651 addresses the effect of a weather report indicating below-minimum conditions after an instrument approach has commenced. Under FAR § 121.651(c), when a pilot has begun the final approach segment of an instrument approach procedure (with visibility reported at or above the published minimums for that procedure) and then receives a later weather report indicating below-minimum conditions, the pilot may continue the approach to the decision height or minimum descent altitude, and landing may be accomplished in accordance with the conditions for the type of approach being conducted.

[8] See Weather Addendum.

At 2349:27, before the windshield wipers were turned on, First Officer Origel verbally confirmed that he had contact with the runway environment, stating "I got the runway in sight." Captain Buschmann quickly replied, "I got it, I got it." According to the NTSB Aircraft Performance Study, the aircraft was at approximately 500 to 600 feet AGL. Thus, the flight crew had the runway in sight before reaching the decision height, with more than adequate visibility to complete the landing. It was not until 2349:38 that Captain Buschmann first requested the windshield wipers.

The conclusion that the flight visibility exceeded the reported RVR and the visibility required to descend below the decision height is supported by the statement of the LIT tower controller, who told investigators that he could see Flight 1420 from the tower when the aircraft was a mile away from the airport. The LIT tower controller said that he did not notice anything unusual about the approach.

As the aircraft neared the decision height, Captain Buschmann appears to have momentarily lost visual contact with the runway, as indicated by his statement at 2350:01.5 that "I can't see it." However, given that First Officer Origel was able to maintain visual contact with the runway throughout the final portion of the approach, it is probable that Captain Buschmann regained visual contact himself almost immediately. Indeed, less than 3 seconds later, when First Officer Origel asked Captain Buschmann, "got it?," Captain Buschmann immediately responded, "yeah I got it." The immediacy of Captain Buschmann's response indicates that he had already regained his view of the runway before First Officer Origel's question and before the decision height was reached. Thereafter, Captain Buschmann flew the aircraft to touchdown. Although the crosswind component of the last reported winds exceeded American's crosswind limitation (but was within the manufacturer's demonstrated crosswind limitation), the crosswind was manageable and there was no wind shear or excessive turbulence.

The aircraft landed at 2350:20 on Runway 4R in the touchdown zone, slightly right of centerline, essentially on speed, and in a slight left crab. The LIT tower controller told NTSB investigators that the landing appeared normal and was within the touchdown zone. However, the aircraft was unable to stop because the ground spoilers did not deploy.

If the ground spoilers had deployed, the aircraft would have stopped on the runway, and the accident would have been prevented. This underscores that spoiler non-deployment was the cause of the accident, not crew decision-making.

It must be stressed that American does not endorse any deviation from the FARs and applicable procedures. Indeed, American insists upon total compliance with the FARs and applicable procedures, including those concerning crosswinds, stabilized approach criteria, approach briefing criteria, and visibility guidelines. However, in the context of this accident investigation, the flight crew's decisions to execute the approach and to land at LIT were not the probable cause, because the landing would have been uneventful if the ground spoilers had deployed.

3. The weather conditions at LIT were a contributing factor, but they did not cause the accident.

The rain at LIT when Flight 1420 arrived contributed to the accident because it created flooded runway conditions that reduced the aircraft's braking and cornering efficiency (and, perhaps, allowed some aircraft hydroplaning to occur). The weather conditions also heightened the flight crew's workload as they prepared for landing, which probably contributed to the inadvertent omission to arm the autospoiler system.

Although the weather conditions contributed to the accident, they were not a cause. The aircraft did not experience wind shear or microburst activity. The flight visibility was above the minimums required to continue the approach below the decision height.[9] The crosswind component of the last reported winds before landing exceeded American's crosswind limitation (although it was within the manufacturer's demonstrated crosswind limitation), but the fact remains that Captain Buschmann piloted the aircraft to the touchdown zone close to the runway centerline. After landing, the crosswind caused most of the flight crew's difficulty with maintaining directional control; however, the directional control problems would not have arisen if the spoilers had deployed.[10] Similarly, if the spoilers had deployed, the effect of any hydroplaning would have been greatly reduced, if not eliminated.[11] In short, the Aircraft Performance Study's conclusion that the aircraft would have stopped on the runway if the spoilers had deployed demonstrates that the weather conditions cannot be assigned a causal role in the accident.

4. Flight crew scheduling did not cause or contribute to the accident.

Flight 1420 was scheduled as the concluding segment of the first day of the flight crew's three-day trip sequence together. Information gathered in the NTSB investigation indicates that the crew was well-rested when they checked in.

FAR § 121.471 provides that a Part 121 certificate holder may not schedule a flight crew member, and no flight crew member may accept an assignment, for flight time in scheduled air transportation if the crew member's total flying time will exceed 8 hours between rest periods. On June 1, 1999, the flight crew had total flight time of

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[9] The flight crew stated that they saw the runway from as far as a mile away, and they landed in the touchdown zone and near the centerline. Also, the LIT tower controller and other ground witnesses have consistently reported that the prevailing visibility was well in excess of the reported RVR readings.

[10] As the Aircraft Performance Study found, because the "spoilers did not deploy on touchdown and the wings continued to bear most of the weight at high speeds, very little reaction force was available at the gear to counter the aerodynamic side forces produced by the left crosswind, and consequently the aircraft drifted to the right." Thus, if the spoilers had deployed upon landing, the directional control difficulties experienced by the flight crew would have been largely eliminated.

[11] The Aircraft Performance Study took into consideration any possible hydroplaning that may have been experienced and found that the aircraft would have stopped on the runway if the spoilers had deployed.

7 hours, 49 minutes. Thus, the flight crew was fully in compliance with the flight-time requirements of FAR § 121.471.

Under American's contract with the APA, flight crew members are limited to 14 hours of on-duty time between rest periods. (The FARs authorize flight crew scheduling of up to 16 hours of on-duty time between rest periods.) The flight crew's on-duty time, calculated according to the APA contract, was 13 hours, 7 minutes. Calculated from actual check-in time, Captain Buschmann had on-duty time of 13 hours, 13 minutes, while First Officer Origel had on-duty time of 13 hours 43 minutes. Thus, whether the flight crew's on-duty time is calculated according to the contractual formula or actual on-duty time, their on-duty time complied with the APA contract and the FARs.

5. The braking and reverse thrust applied after landing did not cause or contribute to the accident.

In the course of the accident investigation, there has been some discussion concerning the flight crew's use of braking and reverse thrust after landing. After analyzing all of the information gathered in the investigation, American believes that the braking and reverse thrust applied by the flight crew did not cause or contribute to the accident.

As the Aircraft Performance Study found, if the ground spoilers had been deployed, the braking applied by the flight crew, together with reverse thrust of 1.3 EPR, would have stopped the aircraft on the runway under the conditions at LIT that evening. Conversely, the Aircraft Performance Study found that the aircraft would not have stopped on the runway in the absence of ground spoiler deployment, regardless of the manner in which braking and reverse thrust were applied. With spoiler non-deployment thus clearly isolated as the cause of the accident, it is evident that the braking and reverse thrust applied by the flight crew after Flight 1420 landed did not cause or contribute to the accident.

6. The design of the Runway 4R safety area and the non-frangibility of the approach light stanchion struck by the aircraft contributed to the severity of the accident.

Although FAR Part 139 generally requires a runway safety area located at the end of a runway to be 1,000 feet in length, the runway safety area for Runway 4R is only 450 feet. A limited runway safety area was allocated to Runway 4R because a longer area would have extended into the Arkansas River floodplain. The result was a runway safety area that did not provide appropriate additional stopping distance for an aircraft that might overrun the paved runway surface.

The inadequate length of the Runway 4R safety area was exacerbated by the presence of a 25-foot slope at the far end of the safety area that was lined with rip-rap for erosion control. This drop-off at the end of the short Runway 4R safety area

constituted an unnecessary hazard awaiting an aircraft that might depart the end of the paved runway surface.

Beyond the end of the Runway 4R safety area and the 25-foot rip-rap slope were non-frangible approach light stanchions serving Runway 22L. FAR Part 139 generally requires that such structures be made of frangible materials. However, the approach light stanchions were constructed of non-frangible steel posts because they are located in the river floodplain area, where they might be subject to damage during flooding. Regardless of the reason that non-frangible approach light stanchions were installed, they constituted yet another unnecessary hazard awaiting an aircraft should it not come to a stop in the abbreviated 450-foot overrun area.

The area below the rip-rap slope where the aircraft came to a rest was not readily accessible to rescue vehicles. Also, the LIT tower controller failed to provide sufficient instructions to emergency personnel regarding the location of the accident. As a result, emergency response was delayed.

The NTSB should address these factors in its recommendations to the Federal Aviation Administration.

Summary

After landing in the touchdown zone near the runway centerline and essentially on speed, Flight 1420 was unable to stop on the runway without the aerodynamic effect of ground spoilers. Quite simply, if the ground spoilers had deployed on landing, there would have been no overrun, and there would have been no accident. The singular importance of the non-deployment of the ground spoilers requires that it alone be identified as the sole probable cause of the accident.

As in most accidents, there were a number of other circumstances that played a role. The circumstances that truly were links in the chain of occurrences leading to the runway overrun, as well as the circumstances that enhanced the severity of the accident after the aircraft departed the runway surface, may be properly considered contributing factors. However, those circumstances should not be included as part of the probable cause determination because they are of lesser significance to the occurrence of the accident than the single circumstance that made the accident inevitable, the non-deployment of the ground spoilers.

AMERICAN AIRLINES' MANUAL REVISIONS

	JUNE 1, 1999	REVISIONS
Before Landing Checklist	• After each item had been accomplished by the pilot responsible for that item, the pilot-not-flying (PNF) would call out the checklist item, call out the appropriate response and then move the corresponding switch on the Mechanical Checklist. Checklist items ALTIMETERS and FLIGHT INSTRUMENTS & BUGS were challenged by the PNF and responded to by both pilots. PNF would call-out "*Before landing checklist complete*" after all the items on the landing checklist were accomplished • PNF was responsible for arming the spoiler lever as part of the checklist.	• The PNF calls out each item on the mechanical checklist, verifies that the item has been accomplished, calls out the appropriate response, and moves the corresponding switch on the Mechanical Checklist. Both pilots now ensure that the ALTIMETERS, FLIGHT INSTRUMENTS & BUGS, GEAR, SPOILER LEVER, and FLAPS & SLATS items are accomplished, and both pilots call out the proper response to those items when challenged by the PNF. The "1000 foot" AFL standard callout for all approaches has been changed to "1000, Before landing checklist complete." • The Captain is responsible for arming the spoiler lever.
Landing Procedures	• Both pilots check to ensure the spoiler lever has moved to the full aft (extended) position. If spoiler lever did not move to full aft position, the Captain, regardless of who is making the landing, would manually deploy the spoilers. • If landing on a slippery runway, use aggressive manual braking or maximum auto brakes. • When the nose gear is firmly on the runway, move reverse levers to idle reverse then apply reverse thrust symmetrically to 1.6 EPR unless safety dictates more thrust. If landing on a slippery runway, do not exceed 1.3 EPR reverse thrust on the slippery portions of the runway, except in an emergency	• Both pilots are still to check to ensure the spoiler lever has moved to the full aft (extended) position. Revised procedure now requires that after landing the PNF verify the spoiler lever position and call out "*Deployed*" or "*No spoilers*," as appropriate. As before, the Captain will manually deploy the spoilers, if necessary, • Auto brakes, if operative, must be armed prior to landing when any of the following conditions exist: ➢ Runway length less than 7000 feet. ➢ RVR less than 4000' or visibility less than ¾ mile. ➢ Runway contaminated with standing water, snow, slush, or ice. ➢ Braking action reported less than good. • In addition, the use of auto brakes is recommended when landing with gusty winds or crosswinds • When the nosewheel is on the ground, the PF will select idle reverse and apply slight forward pressure on the yoke. With the spoilers deployed and directional control assured, reverse thrust may be left at idle or increased to a target of approximately 1.3 EPR. Reverse thrust of more than 1.3 EPR should not be used unless stopping distance is in doubt.
Stabilized Approach	• Stabilized approach criteria required that, before descending below the specified minimum stabilized approach altitude (VFR – 500 feet AFL; IFR – 1000 feet AFL) the aircraft should be: ➢ In the final landing configuration, ➢ On approach speed, ➢ On the proper flight path and at the proper sink rate, and ➢ At stabilized thrust.	• Stabilized approach criteria now require that the aircraft be "at approach speed (VREF + additives)" instead of "on approach speed." • Stabilized approach altitudes now VMC – 500 feet AFL and IMC – 1000 feet AFL. • If the stabilized approach requirements cannot be satisfied by the minimum stabilized approach heights or maintained throughout the rest of the approach, a go-around is required.

Decision-making	• Flight Manual, Part I (Approach & Landing section) included a section regarding weather deterioration after an approach had been started that paraphrased (and cites) the applicable FAR. There was also a section regarding descending below MDA/DH that cites to the applicable FAR and quotes it in its entirety (which includes the required visual reference needed to continue the approach).	• New sections added to Flight Manual, Part I (Approach & Landing section) to aid pilots in approach and landing decision-making and FAR compliance, including: ➢ Discusses the two FAR defined decisions: 1) RVR or visibility to begin the final approach segment, and 2) visual cues required to descend below DH, DA, or MDA. While quantifiable conditions provide the "legal" authority to complete the approach and landing, less quantifiable cues may suggest that an approach or landing should not be initiated or completed. Generally, neither airport authorities nor ATC will close an airport or prohibit landings, regardless of the severity of the prevailing weather conditions. Therefore, the absence of cautions, warnings, or recommendations cannot be taken as an indication of safe runway or airport conditions. ➢ Lists approach decision points and options: 1) Prior to initial descent from cruise altitude – continue, hold, or divert. 2) Prior to entering Final Approach Segment – continue, hold, or divert. 3) Descending below DA/MDA – land or go-around. Includes a list of various individual and cumulative factors that will influence the decision to begin and continue an approach to a landing or missed approach. Pilots should be especially aware of the cumulative factors and trends. ➢ Takeoff and landings are not permitted when thunderstorm is near the airport unless the runway and flight path are clear of thunderstorm hazards. ➢ Dispatcher Role: "The dispatcher shall provide cautions and warnings when warranted. The dispatcher shall not make recommendations to initiate or continue an approach based on graphical weather information."
Crosswind Limitations	• Wind Landing Limits, which included American's self-imposed wet runway and RVR-based limitations, were listed in the Flight Manual Part I. The DC-9 Operating Manual, Volume I (Limitations section) listed only the maximum demonstrated dry runway landing limit.	• DC-9 Operating Manual, Volume I (Limitations section) lists all manufacturer and AA-imposed crosswind limitations. New format for Flight Manual Part I Wind Landing Limit table. • Gusts are to be used when computing crosswind components. • Issued an easy-to-use tabular format Headwind/Tailwind Component chart.

Weather Section & Thunderstorm Avoidance	Thunderstorm avoidance policy • Flight Manual, Part I (Weather section) - "Do not enter or depart terminal areas when such areas are blanketed by thunderstorms except where known thunderstorm free routes exist and are followed." • DC-9 Operating Manual, Volume II (Warning & Alerts): Avoid red and magenta areas of the [onboard weather radar] display by at least 20 miles or more whenever possible.	Thunderstorm avoidance policy • Flight Manual, Part I (Weather section): New table added that lists circumnavigation distances and potential hazards by precipitation type. The precipitation types listed are stratiform rain, convective shower, general thunderstorm, and severe thunderstorm. • "Takeoffs and landings will not be attempted when thunderstorms are near the airport unless the runway and flight path are clear of the thunderstorm hazards." • Flight shall be planned "so as to avoid areas of broken or solid lines of severe thunderstorms using current ground-based radar, actual and forecast weather reports, and any other available information." • "The dispatcher shall not make recommendations to initiate or continue an approach based on graphical weather information." General Thunderstorms Section: • Section has been greatly enhanced and enlarged. • New table for the NWS Video Integrator and Processor (VIP) levels and corresponding radar color and precipitation intensities. Radar • Enhanced and expanded radar operations section in the DC-9 Operating Manual Volume II (Warnings & Alerts).