Submission of the Allied Pilots Association
and Association of Professional Flight Attendants
to the National Transportation Safety Board
Regarding the Accident of American Airlines Flight 1420
MD-82, N215AA

NTSB #DCA 99MA060

ADDENDUM A

Analysis of Crew Fatigue as a Causal Factor in the Crash of American Airlines Flight 1420 at Little Rock, Arkansas on June 1, 1999

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June 22, 2001

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INTRODUCTION

Nothing is more important in the cockpit to ensure aviation safety than rested and vigilant pilots at the controls. However, pilots flying in today's 24/7 aviation environments are subject to sleep loss, excessive wakefulness, and circadian disruption; all of which can cause fatigue that can adversely affect performance and vigilance.

Perhaps the most dangerous aspect of fatigue is that it is insidious; fatigued pilots may feel quite well but not realize the true extent of their impairment. One of its more serious effects is that it can impair judgement and decision-making capability, often during the critical approach and landing phase at the end of a long day. National Transportation Safety Board accident investigations where fatigue has been found to be a causal factor indicate that pilots are more willing to tolerate risks and may fail to change a course of action when conditions warrant when they are fatigued.

Scientific information on sleep and circadian rhythms acquired over the past 40 years has clearly established human requirements for sleep and the detrimental effects of sleep loss and circadian disruption. A variety of sources clearly indicate that fatigue as a result of sleep loss, excessive duty, and circadian disruption can cause pilots to make errors.

NASA has received thousands of pilot reports describing substantive fatigue-related incidents under its confidential Aviation Safety Reporting System (ASRS). Many experts believe that a majority of fatigue-related errors go unreported due to the insidious nature of fatigue, and the fact there is no chemical test to determine fatigue in the blood.

Fatigue was found to be a causal factor in many accidents investigated by the National Transportation Safety Board, including the loss of control of a China Airlines 747 in 1985, the crash of an Avianca 707 at New York City in 1990, the crash of an American International Airways DC-8 at Guantanamo Bay, Cuba in 1993, and the crash of a Korean Air 747 at Guam in 1998. In response, the NTSB has repeatedly called for specific preventative actions including a review and revision of hours of service regulations for pilots and the dissemination of educational materials.

Scientific research and the occurrence of fatigue-related accidents and incidents have clearly established pilot fatigue as a serious hazard to aviation safety.

ACCIDENT SUMMARY

On June 1, 1999, at 11:51 PM CDT, a McDonnell Douglas MD-82, N215AA, operated by American Airlines as flight 1420, overran the end of runway 4R and collided with the approach light stanchion at the Little Rock National Airport (LIT), in Little Rock, Arkansas. The captain and 10 passengers sustained fatal injuries; the remaining 134 passengers and crewmembers sustained various injuries.

BASIC HUMAN PHYSIOLOGY AND FATIGUE FACTORS

A pilot's level of alertness at any time depends upon a complex interaction between four variables:

- Sleep and sleep debt
- Circadian rhythm
- Time since awakening
- Time on task.

SLEEP – A vital human physiological function
Scientists are in agreement that humans need about eight hours of sleep every 24 hours to allow the mind and body to be restored. When it is not obtained, we incur a sleep debt that is cumulative. In other words, a loss of two hours of sleep today and four hours tomorrow would require eight hours plus the six-hour deficit, or fourteen hours, to get back into the groove on the third day. The only thing that can reduce sleep debt is sleep. Pilots are subjected to irregular schedules, nighttime operations and jet lag due to multiple time zone changes – all of which can contribute to an excessive sleep debt that can degrade performance and alertness.

A loss of sleep or excessive wakefulness at the wrong time of day can result in microsleep, the twilight between consciousness and sleep. It typically lasts only a second or two. Anyone who has driven a car for too long at night is likely to have experienced a microsleep event at one time or another.

CIRCADIAN RHYTHM – The Human Biological Clock
Our "body clock" or "circadian rhythm" regulates physiological and behavioral functions on a 24-hour basis. It is the mechanism in our brain that regulates the sleep/wake pattern, body temperature, hormones, performance, mood, digestion, and many other human factors. It is a powerful force that pressures humans to sleep during the nighttime hours, and to remain awake during the day. As such, circadian factors are often the root cause of pilot fatigue due to the 24/7 operational requirements of the aviation industry.

TIME-SINCE-AWAKENING (TSA) – The Time a Person Has Been Awake
The propensity for people to become fatigued varies with the number of hours they are awake. The NTSB has found "time since awakening" (TSA) to be the most critical factor in fatigue related accidents in all modes of transportation. A pilot's time since awakening encompasses the time on task and is always greater.

TIME-ON-TASK or " Duty "
Excessive time-on-task or "duty" as it is referred to in the aviation industry is another principal cause of fatigue for pilots. It should be noted that a pilot's duty period is less than his/her time-since-awakening since a pilot must rise, get dressed, and be transported to the airport before duty begins. The duty period may consist of one or several flights. It normally begins one-hour prior to the scheduled departure of the first flight of the day, and ends approximately 15 – 30 minutes after arrival at the final destination.

AFFECTS OF FATIGUE ON PILOT PERFORMANCE[i]

- Impaired judgment and decision-making – Cognitive Problems
- Increased reaction time, both physical and mental.
- Channelized thinking – concentrating on a single activity or thought
- Fixation – staring or listening to a single source of information.
- Short-term memory loss such as forgetting to change a frequency
- Being easily distracted by unimportant events
- Sloppy flying
- Loss of initiative
- Willingness to accept less in performance standards.

ANALYSIS OF CREW FATIGUE AS A CAUSAL FACTOR IN THE CRASH OF AA 1420

The physiological factors affecting human performance were analyzed singularly and cumulatively for the flight crew. Specific operational factors unique to the crew were considered that may have exacerbated fatigue onset and impairment. Finally, the crew's behavior and performance were analyzed for indications of fatigue.
Note: Excerpts from Human Performance Group Chairman's Factual Report – Addendum 1 - Interview with Dr. David Dinges[ii] (expert witness), are in italic type.

PHYSIOLOGICAL FACTORS

SLEEP HISTORIES AND CUMULATIVE SLEEP DEBT

The amount of an individual's usual sleep is established based on their reported total sleep time at home. This figure is then used as a baseline to calculate the cumulative sleep loss or potentially, the sleep gained in the days preceding an accident. The Captain's prior sleep history was established by interviews with family members. The F/O's sleep history was self-reported. It should be noted that there is often a discrepancy between subjective sleep estimates and the true amount of sleep obtained physiologically.

The Captain[iii]

Relatives described the Captain's activities in the 3 days before the accident as routine. On non-flying days the Captain would typically go to sleep between 2130 and 2200; and wakeup about 0515 to leave for work about 0600. He worked a 5-day work week. The Captain checked in for the first flight of the day at 1038.

Interview with the Captain's family - Excerpts

The Captain's wife described his activities in the 3 days before the accident as routine. She said that on Friday, 28 May, he returned home from work about 1700-1730. That evening they attended a neighborhood block party. From Saturday to Tuesday morning she said it was a quiet period as there were no scheduled events to attend. She was not certain when he went to sleep the night before the accident but thought it would have been about the normal time. She said on the morning of the accident he either woke up at 0800 or left the house at 0800. She was not certain which of the two activities occurred at 0800. She recalled that the timing of the trip did not necessitate an early wake-up. She was not certain whether he had breakfast at the house.

She said that when he worked at the office it was a five-day workweek and he normally went to sleep between 2130 and 2200; and would normally wake up about 0515 and leave for work about 0600. She would not characterize him either as a morning person or an evening person but said if he had his preference he would prefer to sleep in.

She provided additional information through a 6 July 1999 letter in which she further stated that she did not recall the details of his sleep times for the days preceding the occurrence, but believes, based on his usual routine, that he would have retired between 2200-2230 and would have gotten up between 0700-0730 CDT.

First Officer[iv]

On Sunday 30 May 1999, the First Officer traveled from his home in Redondo Beach, CA, to Chicago. He remained in the Chicago area relaxing around the house and was involved in routine activities on Sunday and Monday (30 & 31 May 1999). On Monday he went to bed about 2200 and awoke the next day about 0730 feeling rested. He described his activities on the morning of the accident as normal for a 1044 show time. He signed in for duty at ORD at 1018 CDT.

Summary analysis: Sleep loss does not appear remarkable for the Captain or First Officer.

TIME OF DAY- Circadian Factors

The accident occurred at 2351 hours after a lengthy duty day. Duty that occurs during the late night to pre-dawn hours carries a significant fatigue penalty because of the natural physiological decrement in performance that occurs during that time period. The time of day was also examined in relationship to previous sleep periods and the potential disruption of a usual circadian pattern at the time of an accident.

From Human Performance Group Chairman's Factual Report – Addendum 1:
He said what is relevant, insofar as the circadian system is concerned, is that the accident happened a couple hours after the Captain's usual bedtime. He said this would suggest that the Captain's circadian system was already in its downward phase. He said that the Captain could have gone from feeling pretty good and being more alert when he left Dallas to having an increased physiologic fatigue level as he got closer to Little Rock. Consequently Dinges noted that one key factor in the accident scenario was that the captain was being asked to perform a landing task at a time of night when he would normally be asleep. Dinges said he would not be concerned if the accident had occurred only a couple of minutes past the Captain's normal bedtime—but in this case it was a couple of hours past his bedtime, which was significant. Dinges said that there are published studies that demonstrate that "larks", or morning-type people, do not perform well when they get into the circadian zone of when they are habitually asleep. He said these studies show that larks have difficulty adapting to nightshift work, and they are much more likely to make mistakes after long shifts when they are in the night zone. Dinges said there is reason to believe that based on the literature for larks and owls that the timing of the accident for the Captain, being well past his normal bedtime, may have been challenging for him.

Summary Analysis: The time of the accident was a factor that could have contributed to fatigue in the Captain and First Officer.

Continuous Wakefulness – Time-Since-Awakening (TSA)

At the time of the accident, the Captain had been awake between 16:21 -16:51 hours and the First Officer had been awake for 16:21 hours.

NTSB analysis of domestic air carrier accidents occurring from 1978-1990 indicated that time since awakening was the dominant fatigue-related factor in these accidents and concluded that alertness and performance declines after 13 hours.

The Centre for Sleep Research at the Queen Elizabeth Hospital in South Australia has done considerable research on fatigue and time-since-awakening (TSA) that has been repeated and confirmed by the scientific community.[v] Their findings conclude that human performance after 17 hours of TSA is equivalent to performance with a blood alcohol level of 0.05 percent, and performance after 24 hours of TSA is equivalent to performance with a blood alcohol level of .10 %.

From Human Performance Group Chairman's Factual Report – Addendum 1:
Regarding the Captain's circadian phase at the time of the crash, Dinges felt that total wake time may have contributed to vulnerability to error. He noted that the captain had worked a considerable period of time on the day of the accident and had been up for 16 or more hours. He said that 16 hours of continuous wakefulness really is the limit that anyone would suggest is safe to perform within.

Summary Analysis: Continuous wakefulness or time-since-awakening during the DFW – LIT flight segment was a factor that could have contributed to fatigue in both pilots.

Time-on-Task / Duty

On the day of the accident, the Captain and First Officer signed in for the start of the duty period in Chicago at 1038 CDT and 1018 CDT respectively. The duty period consisted of flights from Chicago to Salt Lake City, Salt Lake to Dallas/Ft. Worth, and Dallas/Ft. Worth – Little Rock. At the time of the accident, the Captain and the First Officer had been on duty for 13:13 and 13:33 respectively.

The Battelle Report concluded that scientific research suggests an increase in the likelihood of error as duty periods are extended beyond 12 hours. This finding is especially critical for extended duty periods that are likely to occur under conditions (e.g., weather) that, in and of itself, may increase the probability of crew error. [vi]

The report included the following reference to supporting research: During daytime, fatigue-dependent vigilance decreases with task duration, and fatigue becomes critical after 12 hours of constant work. During night hours fatigue increases faster with ongoing duty. This led to the conclusion that 10 hours of work should be the maximum for night flying.[vii]

From the Human Performance Group Chairman's Factual Report – Addendum 1:
Dinges was asked about the length of duty days..whether 12, 14, or 16 hours. He said that he would prefer that extensions to 14 and 16-hr duty days not occur unless there is a mitigation of the increased risk of performance failure, like augmentation on long haul flights or the appropriate use of countermeasures. He said that in the absence of risk mitigation, it is difficult to embrace the notion that we

should permit individuals in safety sensitive occupations to be putting in hours that exceed 12, and if we do go to 14 hours, there should be frank acknowledgment of the risk—and some sort of effort to mitigate it.

Summary Analysis: Duty was excessive at the time of the accident and could have contributed to fatigue in both pilots.

ADDITIONAL INFORMATION FROM WITNESSES

Deposition of Flight Attendant who worked on AA 1420
The following is a transcript of a portion of a videotaped deposition. The questions are in reference to the Captain and First Officer's physiological condition as observed by the Flight Attendant prior to departing the gate at DFW.

Attorney: Did either of the flight crewmembers make a comment that you heard about being tired?

Flight Attendant: Yes

Attorney: Which one?

Flight Attendant: Both the Captain and First Officer

Attorney: What do you recall the Captain saying?

Flight Attendant: We've had a long day. ...Make sure to slap me. Make sure I'm awake.

Attorney: What did the First Officer say about fatigue?

Flight Attendant: He had a long day. He was tired.

Testimony of the First Officer at NTSB Hearing - January 26, 2000
Question: Were you fatigued or tired at the time of the departure from Dallas?

Answer: I would say I was tired but alert.

Question: I believe you had mentioned that at – somebody asked you earlier about your—whether you were tired or not at DFW. Let's go a little further. On the DFW-Little Rock leg, did you feel tired or fatigued in any way?

Answer: I don't recall. It was—it was a short but busy flight, and the First Officer's position in the DC-9 is busy. So I remember being busy with the work, if you will, but I don't remember actually talking about being tired or – or being distracted.

Question: Okay. During—during that leg of the flight, do you recall the Captain making any statement or taking any action or doing anything that led you to believe he was fatigued or tired?

Answer: During the flight, no, but during – upon review of the CVR, I can hear a few things that indicate that. A yawn at one point I believe.

OPERATIONAL FACTORS INCREASING FATIGUE RISK

An atmosphere had been created to get the flight off the gate as soon as possible and on its way to Little Rock to avoid a cancellation. As the crew approached Little Rock, they received updates from dispatch regarding the bad weather approaching Little Rock, which created more ominous time pressure to reach their destination.

From the Human Performance Group Chairman's Factual Report – Addendum 1:
Time pressure and frequently changing wind information would make effective performance even more difficult in a fatigued pilot, and therefore increase the likelihood of errors in the Captain.

Time Pressure

He said he saw evidence of time pressure (to complete the flight and to avoid the storm.). Dinges noted that such time pressure would create a work-paced environment, and would have the effect of eliminating the flight crews' option to slow performance to maintain accuracy.

Increased Workload Due to Changing Conditions

In addition, the frequent and changing radio reports from ATC during approach and landing also demanded attentional resources and added to the work-paced nature of the performance demands.

Deteriorating weather and visibility

In addition, Dinges commented that in his opinion the crew was paying significant attention outside the cockpit to the storm and to the visual identification of the airport and runway during the approach. This prioritization and the cognitive resources allocated to it could lead to the potential to overlook other cockpit tasks.

Stressful / Demanding Situation

Dinges said he would suspect from a biological standpoint that there was a fair amount of stress involved at this time in addition to fatigue. Dinges said that it was important to recognize that the fatigue in this situation was not drowsiness where someone falls asleep on the job. He said that although he felt the Captain was fatigued, he did not think either pilot was feeling sleepy, primarily because of the stressful nature of the approach and landing. He said instead he saw this situation as a difficult and demanding situation that was at the performance limits of what could be expected for these people at this time of day under these conditions.

Interview with Dr. Mark Rosekind[viii]

Rubin: Some flights are easier to deal with than others when it comes to weather or the size of the runway you have to land at. How does that come into play?

Rosekind: That is a critical part of the decision making process. Especially if you have these flags that say there are some physiological risks here. What you have to include in that decision is do we have any weather problems, or mechanical problems? Is there time pressure because we've already been delayed? We want to get these people to their destination. All of these things have to be considered, because they will pressure you or push decisions in ways that if you were more rested, you would be saying, why would we be doing this?

CREW PERFORMANCE AND FATIGUE FACTORS

The performance of the crew was analyzed using the cockpit voice recorder transcript[ix], the Group Chairman's Factual Report of Operational Factors[x], and the testimony of the First Officer[xi]. The actions of both crewmembers were examined to determine if any characteristics of fatigue were apparent during the operation of flight 1420.

PERTINENT OBSERVATIONS

The Captain was a highly experienced Chief Pilot who was flying the aircraft with non-flying duties assigned to a relatively new First Officer on probation.

Twenty-five minutes before landing and just before beginning descent from cruising altitude, the First Officer was very much "in the loop". He noted correct fuel pump usage, prompted the Captain to commence the descent, and suggested that the flight attendants be seated earlier due to possible turbulence.

Sixteen minutes before landing the crew received information that Little Rock Airport was reporting winds of 280 degrees at 28 knots gusting 44. The crew discussed and appeared confused about crosswind landing minimums.

When a controller asked if the crew wanted a visual approach, the Captain declined. Three minutes later, approach repeated the request and the Captain did not respond verbally. After the First Officer accepted a visual approach, the Captain said, "Well, you keep me straight. Where is the airport?" When he couldn't find it, he said, "Just vector me" and struggled to find the airport visually while being vectored by the First Officer. One minute later he said, "I don't think we can maintain visual", whereupon the First Officer advised approach that they had lost the field and the controller responded with vectors for the ILS.

The crew received numerous advisories about wind shear, heavy rain, severe gusts, crosswinds, and limited visibility at the airport as it approached Little Rock but did not discuss the possibility of diverting to the alternate airport, holding, or returning to DFW.

As the crew maneuvered around thunderstorms, the First Officer said, " We're getting pretty close to this storm. We'll keep it tight if we have to." Just seconds later, flying through a lower cloud layer, the Captain commented, "It's not worth it".

Less than 5 minutes before touchdown, the Captain said, "I hate droning around visual at night in weather without having some clue where I am." The First Officer responded, "Yeah but, the longer we go out here..." The Captain responded, "yeah, I know."

Four minutes to touchdown, the tower gave the wind report and field conditions as wind 350 at 30 gusts to 45 (35 knot crosswind) – wind shear alerts – heavy rain - visibility less than 1 mile – and RVR 3000. This triggered a discussion and apparent confusion about landing minima between the crew.

Two and ½ minutes to touchdown, the tower gave the new RVR as 1600 feet. The First Officer responded with an expletive to the Captain who responded with an assertion that they were established on final, ostensibly to assure the First Officer that they were legal to continue with the approach.

The First Officer prompted the Captain to set flaps at 28 while on final approach.

Descending through 1000 feet on the approach the Captain was prompted by the First Officer to set the flaps at 40. He responded, "Oh yea, thought I called it." Eight seconds later and one minute to touchdown, he said, "This is a can of worms," as he continued the approach.

The First Officer testified that at 1,000 feet, he was behind the aircraft but catching up.

Descending through 500 feet above field level and thirty seconds before touchdown, the First Officer called out twice, "we're off course...we're way off." The Captain responded, "I can't see it", but then acknowledged seeing the runway 5 seconds later, approximately 15 seconds before touchdown.

In his testimony, the First Officer states that he said "Go Around" when the approach appeared unstable very close to touchdown. When asked if the Captain had heard him, he responded "I don't know...it sounds like we talked at the same time, and he may not have heard what I said."

As the aircraft descended through 100 feet, the GPWS sounded the "sink rate" warning repeatedly until passing fifty feet.

After landing, the crew did not ensure ground spoiler deployment and the Captain exceeded recommended reverse thrust limits. The aircraft touched down right of the centerline of runway 04R in a crab, overran the end of runway 4R, and collided with the approach light stanchions of runway 22L.

APPARENT OPERATIONAL ERRORS

1. Crosswind landing limits were exceeded for a wet runway.
2. The Before Landing checklist may not have been completed.
3. The Captain failed to initiate a go-around during the approach after being advised by the First Officer that he was off course while non-stabilized, and after losing momentary visual contact with the runway.
4. The crew failed to ensure ground spoiler deployment after landing.
5. The Captain used excessive reverse thrust after landing.

FATIGUE CHARACTERISTICS EVIDENT IN CREW PERFORMANCE

COGNITIVE PROBLEMS – JUDGEMENT AND DECISION MAKING ERRORS

- The Captain did not consider diverting to alternate airport or holding for weather after receiving repeated updates of deteriorating weather conditions at Little Rock Airport.

- There was insufficient attention by the crew to critical data and operational requirements.

- The Captain failed to initiate a go-around during the approach to Runway 4R after being advised by the First Officer that he was off course while non-stabilized, and after losing momentary visual contact with the runway.

From Human Performance Group Chairman's Factual Report – Addendum 1
He said that relative to time, they were so focused on getting the airplane on the runway in a timely manner, that they may have lost sight of what was going to happen after they touched down. Dinges said that in general, when people are fatigued, they are likely to make a bad decision about the next thing they will do. He said the reason for this is unknown and there isn't a great deal of information about it. He said it is assumed to be a failure of the individual to consider their options. Dinges said that time pressure can also lead to bad decisions.

Dinges said that there were a number of instances where something was said and the captain asked for it to be repeated. He said this appeared to be a sign that the Captain in particular was having cognitive allocation problems because of the multiple attentional demands that were required during approach and landing, and the pace of the information coming in. Dinges said that the presence of distracting sounds makes a task more difficult for a fatigued person. He said a fatigued person would tend to ignore these sounds even if they are warnings.

Dinges said he felt the Captain was motivated, committed and professional, but he was also tired, especially during the approach and landing. Dinges said that the performance of the flight crew during approach and landing, including both the accuracy of landing the airplane on the correct runway and the apparent failure to arm the spoilers and stop the airplane in a timely manner after landing were responses consistent with ASRS reports related to fatigue that he has reviewed.

CHANNELIZED THINKING – Concentrating on a single activity or thought
The crew was focused on beating the storm and did not consider diverting to an alternate or holding until conditions improved. The Captain disregarded critical information that would normally have been criteria to execute a go-around. This included the statement by the First Officer that he was way off course and indications that his approach was not stable as evidenced by the GPWS "Sink Rate" alert that sounded repeatedly from 100' to 50' above field level.

From Human Performance Group Chairman's Factual Report – Addendum 1
Dinges said that after reviewing the CVR transcript, what seemed evident to him was that the way things were being prioritized by the Captain during the final minutes of the flight fit with what is known about fatigued performance. There appeared to be a focus outside of the cockpit (toward the storm and the airport), with a priority to land the plane on the target runway.

FIXATION
The Captain was extremely fixated to maintain visual contact with the airport and runway while maneuvering for the approach. During this period, he failed to call for flaps 28 and flaps 40 while maneuvering and on the approach.

From Human Performance Group Chairman's Factual Report – Addendum 1
Dinges said that his review of the CVR in AAL1420 left him with the impression that the crew experienced a loss of situational awareness in space and time. He said that relative to space, they were so focused on maintaining situational awareness outside the airplane (toward the storm, a airport and runway) that they may have lost sight of things inside the cockpit relevant to prepare for landing.

Fixation was a characteristic found evident by the NTSB in the crash of a DC-8 at Guantanamo Bay in 1993: "During the crucial period leading up to the accident, the Captain displayed an overwhelming focus and concern to locate the strobe light. This fixation on the strobe light, to the exclusion of other critical information, could also be an expression of the effect of fatigue on performance." [xii]

LOSS OF INITIATIVE
The Captain was prompted on two occasions by the first officer to commence the descent. The Captain failed to initiate a go-around during the approach to Runway 4R after being advised by the First Officer that he was off course while non-stabilized, and after losing momentary visual contact with the runway.

According to former NTSB Chairman Jim Hall: "The failure of crews to take alternative action has been observed repeatedly in accidents involving fatigue." [xiii]

MEMORY IMPAIRMENT
The Captain was reminded on two occasions to set flaps 28 and flaps 40. He said to the First Officer, "I thought I already called for them" in reference to the call for flaps 28, but the CVR revealed that he did not.

WILLINGNESS TO ACCEPT LESS IN PERFORMANCE STANDARDS
By all reports, the Captain was lauded for his airmanship and good judgment as a professional aviator and Chief Pilot. It is probable that under normal circumstances he would have emphasized and demonstrated the need to accomplish all checklists carefully and ensure that landing minima and pertinent operational restrictions were met before making any landing attempt.

CONCLUSION

The crew of flight 1420 had already flown two legs around bad weather, encountered lengthy delays, were on duty almost fourteen hours, and continuously awake approximately 17 hours at the time of the accident. Oral testimony provided evidence that both crewmembers were tired before departing DFW for Little Rock.

The accident occurred several hours past the habitual sleep period of the Captain. As such, it was probable that these combined factors caused him to become fatigued which adversely affected his performance during the flight. As stated in the Human Performance Group Chairman's Factual Report – Addendum 1: *"... this prolonged wakefulness, coupled with the fact that the accident occurred at night approximately 2-2.5 hours past the Captain's habitual bed time, make it highly likely that the Captain was fatigued at the time of the crash."*[xiv]

The crew had to deal with several critical operational problems during flight 1420. These included time pressure to depart DFW before the crew became illegal, time pressure to arrive at Little Rock before the storm, increased workload due to changing weather, and the deteriorating weather and visibility during the final moments of the flight. These stressful and demanding situations exacerbated the onset of fatigue and extent of impairment.

As the flight neared Little Rock, the Captain had difficulty assimilating and processing critical operational information. He directed his attention to flying the aircraft and avoiding bad weather while suffering a loss of cognitive function due to fatigue and task saturation. This is most apparent by his failure to initiate a go around during the final moments of his approach.

Analysis of the crew's performance and errors committed during the flight of AA 1420 reveals definite characteristics of impairment due to fatigue. These include degradation in judgment and decision-making (cognitive problems), channelized thinking, fixation, loss of initiative, memory impairment, and a willingness to accept less in performance standards. As stated in the Human Performance Group Chairman's Factual Report- Addendum 1: *"..the performance of the flight crew during approach and landing, including both the accuracy of landing the airplane on the correct runway and the apparent failure to arm the spoilers and stop the plane in a timely manner after landing were responses consistent with ASRS reports related to fatigue that he has reviewed."* [xv]

Pilot fatigue was a primary causal factor in the crash of AA flight 1420 at Little Rock, Arkansas on June 1, 1999.

RECOMMENDATIONS

1. UPDATE FAA FLIGHT AND DUTY TIME REGULATIONS

Reducing the threat of pilot fatigue should be one of the FAA's highest priorities. For more than a decade, the NTSB has been calling for the FAA to modernize hour of service regulations that reflect the latest scientific findings on fatigue. They are sorely needed and long overdue.

In 1996, NASA published *Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation*[xvi] following 15 years of extensive research that examined pilot fatigue in diverse flight operations. NASA recommends the following flight duty period limitations for domestic operations. *Note: NASA's definition of a "flight duty period" is the same as what has been referred to herein as "Duty Period".*

1. To reduce vulnerability to performance-impairing fatigue from extended hours of continuous wakefulness and prolonged periods of continuous performance requirements, cumulative flight duty per 24 hours should be limited. It is recommended that for standard operations, this cumulative flight duty period not exceed 10 hours within a 24-hour period.

2. An extended cumulative flight duty period should be limited to 12 hours within a 24-hour period to be accompanied by additional restrictions and compensatory off-duty periods. This limit is based on scientific findings from a variety of sources, including data from aviation that demonstrate a significantly increased vulnerability for performance-impairing fatigue after 12 hours.

2. FATIGUE AWARENESS TRAINING

Pilots should receive continuing education about the latest scientific findings on fatigue, countermeasure techniques, and when it is prudent not to fly due to fatigue risk. A fatigue awareness training video produced by APA for the 11,000 pilots at American Airlines is available from APA on request for training purposes.

REFERENCES / ENDNOTES

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[iv] Human Performance Group Chairman's Factual Report – October 12, 1999

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[viii] Fatigue: The Insidious Threat, training video, Allied Pilots Association, 2001
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[ix] Cockpit Voice Recorder transcript of AA 1420

[x] NTSB Operations Group Chairman's Factual Report on AA 1420

[xi] Testimony of First Officer at NTSB Hearing on AA 1420 at Little Rock

[xii] NTSB Aircraft Accident Report – AIA 808 at Guantanamo Bay, Cuba, 1993 PB94-910406

[xiii] Fatigue: The Insidious Threat, training video, Allied Pilots Association, 2001

[xiv] Human Performance Group Chairman's Factual Report – Addendum 1, page 7.

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[xvi] Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation, NASA Technical Memorandum 110404, May 1996.

Submitted this 22nd **day of** June **, 2001**

[redacted]

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