Submission to the

National Transportation Safety Board

for the

Investigation of National Airlines Flight 102

Boeing 747-428BCF, N949CA

Bagram, Afghanistan, April 29, 2013

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Executive Summary

1. Factual Information

1.1 History of Flight

(a) Flight and Accident Sequence

On April 29, 2013, National Airlines Flight 102, a Boeing 747-400 converted freighter, crashed shortly after takeoff from Bagram Air Base (OAIX). (Operations Factual Report, pages 5 and 20). The aircraft was totally destroyed by the impact and post-crash fire. (Operations Factual Report, page 5). The seven crewmembers onboard were fatally injured. (Operations Factual Report, page 5). The original route of the flight was from OAIX to Dubai, United Arab Emirates, Al Maktoum International Airport (OMDW). (Operations Factual Report, page 5).

The flight was being operated as part of the International Security Assistance Force (ISAF), outlined in United Nations Security Council Resolution 1386 (adopted 2001). (Operations Factual Report, page 6). National Airlines operated a multi-modal contract with US TRANSCOM (Contract Number HTC711-12-D-R010) to transport military equipment. (Operations Factual Report, page 6). Flight 102 was denoted ISAF 95AQ (I95AQ) for Air Traffic Control (ATC) purposes. (Operations Factual Report, page 7). The flight included a crew of seven, four pilots, two mechanics and one loadmaster. (Operations Factual Report, page 7). The aircraft crashed at 1527 local time (1057 UTC). (Operations Factual Report, pages 4-5).

The original schedule for the crew was to operate Flight NCR510 from Chateauroux, France (LFLX) to Camp Bastion, Afghanistan (OAZI) and then continue NCR510 departing Camp Bastion to Dubai (OMDW). (Operations Factual Report, page 7). The flight was unable to obtain an overflight permit for the flight departing Camp Bastion. (Operations Factual Report, page 7). This resulted in a refuel stop at Bagram and then continuation to OMDW. (Operations Factual Report, page 7).

The aircraft was loaded at Camp Bastion, including five Mine Resistant Ambush Protected (MRAP) armored military vehicles. (Operations Factual Report, page 7). The flight data recorder (FDR) recorded takeoff gross weight was 676,000 pounds. (Boeing FDR Data Study, page 3). FDR data show the airplane was configured for a flaps 10 takeoff with a recorded stabilizer setting of approximately -0.85 degrees, consistent with the aircraft's preflight weight and balance. (Boeing FDR Data Study, page 3). A review of the weight and balance following the accident indicates the aircraft gross weight may have been 685,000 lbs. accounting for 20 foot pallets, wood shoring, straps, tie downs, and accurate weights for the MRAPs. (Boeing FDR Data Study, page 3).

NCR102 taxied out normally for departure on runway 03 at Bagram at 1044:53Z. (Operations Factual Report, page 8). Recorded information shows that the captain was the pilot flying (PF) and the first officer was the pilot monitoring (PM). (Operations Factual Report, pages 65-66). Meteorological Aviation Reports (METARs) reported that at 1055Z, the winds were at 7 knots from 20 degrees true (north-northeast). (Operations Factual Report, page 8). There were scattered clouds at 4,000 feet with a broken ceiling at 8,000 feet. (Operations Factual Report, page 8). Special Weather Observations were taken at 1058Z and 1059Z, indicating an air mass

change resulted in a 7 degree decrease in temperature and wind gusts at 11 knots from 350 degrees true north. (Operations Factual Report, page 53).

At 1045:32Z during its taxi, NCR102 received the following ATC departure clearance to Dubai:

> *Direct to SIBLO via diverse vectors. On departure fly runway heading until 3 DME, then turn left heading two one zero. Climb and maintain two eight zero, squawk zero four seven three. Departure frequency on two four point eight.*

(Operations Factual Report, page 8).

NCR102 acknowledged the takeoff clearance at 1055:47Z. (Operations Factual Report, page 8). There were no further communications between NCR102 and Bagram ATC. (Operations Factual Report, page 8). According to interviews with ATC tower personnel, all communications with the accident crew were normal, and the takeoff roll appeared normal. (Operations Factual Report, page 8).

Per the recorded FDR information, maximum takeoff thrust was used (engine N1 = 108 percent). (Boeing FDR Data Study, page 3). Slight left rudder, on average, was commanded during the takeoff roll to maintain runway centerline. (Boeing FDR Data Study, page 3). Fluctuations in computed airspeed were observed during the takeoff roll consistent with gusty wind conditions. (Boeing FDR Data Study, page 3).

Calculations based off of the FDR information indicated the airplane rotated around the Charlie intersection of the runway, which, according to ATC interviews, was a typical rotation point for the B747. (Operations Factual Report, page 8). Rotation was initiated with a nose-up column input at a speed of approximately 153 knots, and the airplane rotated to a normal takeoff pitch attitude. (Boeing FDR Data Study, page 3). Approximately 9 seconds after the Captain called for the First Officer to rotate the airplane, the cockpit voice recorder (CVR) stopped recording, and approximately 3 seconds later the FDR stopped recording. (Operations Factual Report, page 8). Valid data ended with the airplane at 33 feet radio altitude and 171 knots computed airspeed. (Boeing FDR Data Study, page 3). The airplane was pitched at approximately 13 degrees and banked right at approximately 4 degrees. (Boeing FDR Data Study, page 3). Elevator deflections were around 5-6 degrees trailing edge up when the data ended. (Boeing FDR Data Study, page 3). The last valid recorded wind data indicate the winds were approximately 12 knots from 40 degrees true, a marked change in speed and direction from the pre-departure METARs. (Boeing FDR Data Study, page 3). The left rudder used during the takeoff roll (runway magnetic heading=27 degrees) was consistent with the recorded wind data (right crosswind). (Boeing FDR Data Study, page 3). According to witnesses and video evidence, after becoming airborne, the airplane continued to pitch up until it appeared to stall, turned to the right, and then descended to impact with the ground just beyond the departure end and to the right of runway 03. (Operational Factors Attachment 1, pages 3, 7, and 15).

(b) Cargo and Loading

On April 26, 2013, the load planning department for National Air Cargo in Dubai, UAE contacted the National Airlines Chief Loadmaster advising that National Air Cargo was planning to load 5 Mine Resistant Ambush Protected (MRAP) armored military vehicles on the National

Airlines flight from Camp Bastion to Dubai on April 29, 2013. (Operations Factual Report, page 25). The text of the email sent to the National Airlines Chief Loadmaster from the National Air Cargo load planning department in Dubai stated:

> We are expecting 3xMRAP (18800 to 19000KG, Including ULD/Shoring) from OAZI on next NAL Flight rotation to DWC ,vehicles are built on sandwich pallet with support of enough shoring . Kindly let us know the Laudability .
> In addition to these three vehicle we are looking two more vehicle weighing around 12000KG each on same flight.
>
> Please let us know any additional precaution we need to take before confirming the load.

(Operations Factual Report, pages 25-26).

The National Airlines Chief Loadmaster responded the same day via email:

> That shouldn't be a problem. We just need to make sure we have enough ballast in the front to prevent the aircraft from tipping and for weight and balance.

(Operations Factual Report, page 26).

Three of the vehicles were 4-wheel drive MRAP "Cougars" weighing 18 tons each, and two were MRAP All-terrain Vehicles (MRAP ATV, or MATV's) weighing 12 tons each. (Operations Factual Report, page 26).

On April 26, 2013, the National Air Cargo Dubai load planner sent a pre-planned load sheet to Camp Bastion indicating an initial load of 95,313 kilograms (235,752 pounds) that included the five MRAPs. (Operations Factual Report, page 26). National Air Cargo evaluated the load and decided double pallets should be used for the heavier vehicles. (Interview of Allen Robert White, Operational Factors, Attachment 1, page 19). (Operations Factual Report, page 26). The cargo loaders were provided with pictures of the load to assist with pallet buildup and tie downs. (Interview of Ralph Brown, Operational Factors, Attachment 1, page 13 and Interview of Allen Robert White, Operational Factors, Attachment 1, page 19). The loaders were familiar with palletized heavy vehicles, as National Air Cargo had previously provided instructions to them on how to palletize a 12-13 ton Stryker combat vehicle. (Interview of Luis Gregorio, Operational Factors, Attachment 1, page 17).

National Air Cargo employees began loading the accident airplane on the morning of April 29, 2013. (Operations Factual Report, page 27). The first 12-ton MRAP was loaded using the National Air Cargo 14-ton lift, and placed in the forward section of the aircraft structure. (Operations Factual Report, page 27). The ground crew then stopped loading at 0630 local time and waited for the military to arrive with their 60-ton Atlas "K-loader" so the 18-ton Cougars could be lifted. (Interview of Ralph James Brown, Jr., Operational Factors, Attachment 1, page 8). The loading of the remaining MRAPs occurred at about 0830 local time. (Operations Factual Report, page 27).

Because the MRAPs were too large to drive onto the main deck of the B747-400, each of the MRAPs were placed on aluminum pallets. (Operations Factual Report, page 27). Twenty-foot PGF commercial pallets were used for the 12 ton vehicles, whereas the loadmaster decided to build a double-pallet for the 18 ton vehicles. (Interview of Ralph James Brown, Jr., Operational Factors, Attachment 1, page 9)

The National Air Cargo Operations Specialist used 14 chains to secure the 12-ton MATVs to the pallet. (Operations Factual Report, page 28). For the 18-ton Cougars, the Specialist built a "double-pallet" comprised of one pallet on top of another pallet, with plywood between the two aluminum pallets to reduce friction. (Operations Factual Report, page 28). The two pallets were attached to each other with straps, three lengthwise and two widthwise, for five straps total. (Operations Factual Report, page 28).

According to interviews, National Air Cargo personnel chained the Cougars down with eight chains attached to the top pallet and six chains attached to the bottom pallet for a total of 14 chains. (Operations Factual Report, page 29). Two chains were attached to the bottom, and two backwards and forwards, and the same on the other side of the vehicle. (Operations Factual Report, page 29). The axle chains were the only ones attached to the top pallet. (Operations Factual Report, page 29). Due to the weight of each of the vehicles, shoring (load spreading) was used underneath each vehicle via wood blocks. (Operations Factual Report, page 30).

The pallets and vehicles were then loaded on the main deck of the B747-400. (Operations Factual Report, page 27). The pallets were restrained with straps attached to the main deck. (Operations Factual Report, page 27). Because the palletized cargo was loaded into the center of the main deck and secured to the main deck itself using seat tracks, the pallets were called center-loaded "floating pallets," a practice often utilized by National Airlines and the cargo industry generally. (Operations Factual Report, page 27).

The front vehicle was a 12-ton MATV, followed by the three 18-ton Cougars. (Operations Factual Report, page 31). The aft-most vehicle was a 12-ton MATV, and was located near the main cargo loading door in the aft of the airplane. (Operations Factual Report, page 31). The pallets were secured to the aircraft with the use of straps. According to the National Air Cargo loaders, 24 straps were used to secure the 12 ton vehicles, and 26 straps were employed for the 18 ton vehicles. (Operations Factual Report, page 36). After landing in Bagram, it is possible additional straps were added in the loadmaster's discretion. (COM Rev. 8, Ch. 6, Section 4.4).

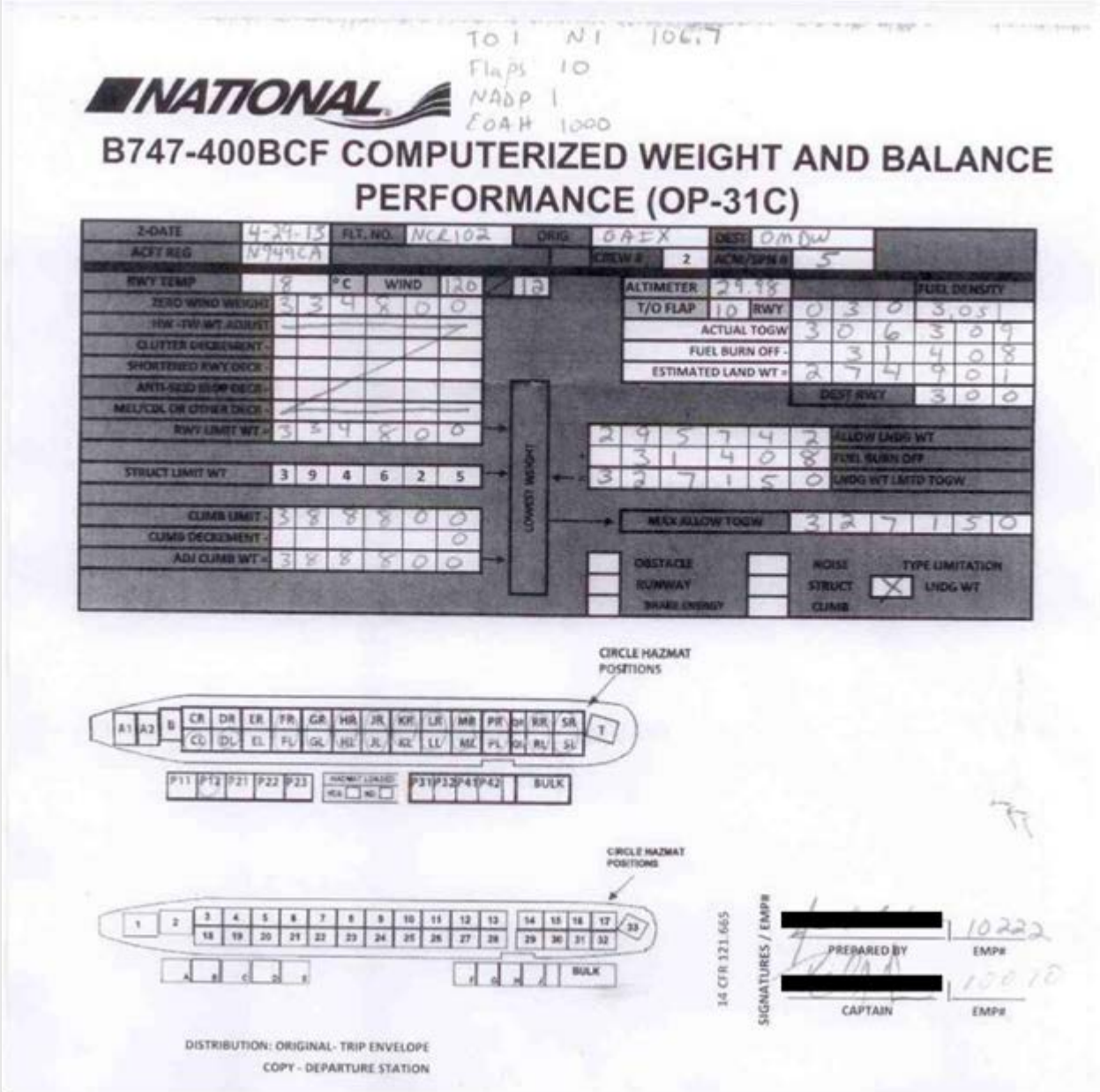
The weight and balance loading process was documented in a completed Load Manifest that ensured the aircraft was loaded in such a way that all weight restrictions were complied with and that the center of gravity was within its envelope for the entire flight. (Operations Factual Report, page 50).

Flight 102 departed Camp Bastion at 0745Z and arrived into Bagram at 0923Z. (Operations Factual Report, page 7). On arrival into Bagram, the crew experienced a brake overheat condition after landing on runway 03. (Operations Factual Report, page 7). The crew parked the airplane on the Foxtrot ramp. (Operations Factual Report, pages 7-8). The crew then ran a checklist to address the brake temperature indications in the cockpit, and discussed the required cooling time of 1 to 1.5 hours. (Operations Factual Report, page 8). The airplane refueled to 48,000 kilograms of fuel, but did not take on any additional cargo. (Operations Factual Report, page 8). A National Air Cargo ground crew met the airplane during refueling and conferred with the loadmaster at the entrance of the main deck door. (Operations Factual Report, page 8).

The National Airlines Weight and Balance Manual, Section 8.8 "Load Manifest" page 1-11 stated the following in part:

> The Captain, Loadmaster or other qualified personnel who have been properly trained, may be delegated the authority for performing the weight and balance computation for each flight. The Captain is responsible for ensuring that the aircraft does not exceed any performance limited weight or center of gravity limits. The Captain has final responsibility.

The weight and balance sheet for the accident flight is set forth below.



(Operational Factors – Attachment 21 – Weight and Balance, page 8).

1.2 Crew Information

The accident crew consisted of two captains, two first officers, two mechanics and one loadmaster. (Operations Factual Report, page 9). The two additional pilots (captain and first officer) were considered augmented flight crew members so the flight could be operated under the provisions of 14 CFR 121.523. (Operations Factual Report, page 9). This regulation provides:

> b) Each certificate holder conducting supplemental operations should schedule its flight hours to provide adequate rest periods on the ground for each airman who is away from his principal operations base. It shall also provide adequate sleeping quarters on the airplane whenever an airman is scheduled to be aloft as a flight crewmember for more than 12 hours during any 24 consecutive hours.
>
> c) No certificate holder conducting supplemental operations may schedule any flight crewmember to be on continuous duty for more than 30 hours. Such a crewmember is considered to be on continuous duty from the time he reports for duty until the time he is released from duty for a rest period of at least 10 hours on the ground. If a flight crewmember is on continuous duty for more than 24 hours (whether scheduled or not) duty [sic] any scheduled duty period, he must be given at least 16 hours for rest on the ground after completing the last flight scheduled for that scheduled duty period before being assigned any further flight duty.

(Operations Factual Report, page 9).

A flight crew member assigned to a crew of 3 or more may not be scheduled to be on continuous duty for more than 30 hours. (Operations Factual Report, page 9). Further, according to the National Airlines General Operations Manual, when any flight crew member was scheduled to be aloft as a flight crewmember for more than 12 hours in any consecutive 24 hours, adequate crew rest facilities shall be aboard the aircraft. (Operations Factual Report, page 9).

The National Airlines General Operating Manual (dated September 13, 2012), Section 6.3.6 "Heavy (Double) Crew (747 Aircraft)" stated, in part:

> *The 747 aircraft can also be flown with a Heavy (sometimes referred to as a Double) Crew due to its rest facility. This crew consists of 4 pilots. As highlighted above under augmented crew (747 aircraft), this type of crew can have a duty day of 30 hours.*

(Operations Factual Report, page 9).

(a) Captain

The accident captain was 34 years old. (Operations Factual Report, page 10). His date of hire with National Airlines was June 3, 2004. (Operations Factual Report, page 10). He upgraded on the B747-400 on June 22, 2012, having previously served as a captain on the DC-8. The captain was current and qualified under National Airlines and FAA requirements. (Operations Factual

Report, page 10). He had no prior history of accidents, incidents or enforcement actions. (Operations Factual Report, page 10).

The captain's certificate history was as follows:

Private Pilot, Airplane Single Engine Land	Certificate issued 5/4/1999
Commercial Pilot, Airplane Single Engine Land	Certificate issued 5/14/2001
Commercial Pilot, Airplane Single Land, Instrument Airplane	Certificate issued 8/14/2001
Flight Instructor, Airplane, Single Engine	Certificate issued 1/30/2002
Flight Instructor, Airplane, Single Engine, Instrument Airplane	Certificate issued 12/19/2003 Renewed 12/8/2005, 12/18/2007, 12/29/2007, 12/30/2011
Commercial Pilot, Airplane Single and Multiengine and Instrument Airplane	Certificate issued 1/9/2004
Airline Transport Pilot, Airplane Multi-Engine Land, DC-8 (DC-8 Circ. Apch. VMC Only, ATP Circ. Apch. VMC Only), Commercial Privileges Airplane Single Engine Land	Certificate issued 7/21/2006
Airline Transport Pilot, Airplane Multi-Engine Land, B-747-4 DC-8 (DC-8 B747 Circ. Apch. VMC Only, ATP Circ. Apch. VMC Only, English Proficient), Commercial Privileges Airplane Single Engine Land	Certificate issued 6/22/2012

(Operations Factual Report, page 11).

The captain’s flight times were as follows:

Total pilot flying time	6,000
Total Pilot-In-Command (PIC) time	4,700
Total B747-400 time	439
Total B747-400 PIC time	439
Total flying time last 24 hours	14
Total flying time last 30 days	74
Total flying time last 90 days	162
Total flying time last 12 months	561

(Operations Factual Report, page 12).

The National Airlines check airman who last provided the accident captain his B747-400 proficiency check said the accident captain was well prepared and dedicated. (Operations Factual Report, page 10). The check airman also said the captain was "excellent" in his training, and "was a pleasure to be an instructor for" and "pretty sharp." (Operations Factual Report, page 10). One National Airlines first officer stated he remembered the accident captain as being very knowledgeable and having great CRM (Crew Resource Management) procedures. (Operations Factual Report, page 10).

The accident captain completed 12 OAIX (Bagram Airfield) operations within the preceding 12 calendar months. (Operations Factual Report, page 12).

Prior to departing on his sequence of flying, the accident captain was scheduled off days from April 8, 2013, to April 17, 2013. (Operations Factual Report, page 12). On April 18, 2013, he travelled from his home base in Detroit, Michigan, to Ramstein Air Base, Germany where he had 28 hours and 15 minutes off duty before his next flight assignment. (Operations Factual Report, page 12). On April 20, 2013, he operated as part of a "heavy" crew (2 captains and 2 first officers) from Ramstein Air Base, Germany to McGuire Air Force Base, and then deadheaded on the aircraft to Rockford, Illinois, for a total duty day of 18 hours 58 minutes and a block time of 8 hours 29 minutes. (Operations Factual Report, page 12). In Rockford, Illinois, he was off duty for 31 hours and 40 minutes. (Operations Factual Report, page 12).

On April 22, 2013 he was part of a "heavy" crew that positioned the aircraft from Rockford, Illinois, to Kunsan Air Base, Korea. (Operations Factual Report, page 12). The total duty was 16 hours and one minute with a total block of 14 hours 08 minutes. (Operations Factual Report, page 12). At Kunsan Air Base, he was off duty for a total of 20 hours 58 minutes. (Operations Factual Report, page 12).

On April 23, 2013, he was part of a "heavy" crew that operated three segments, originating at Kunsan Air Base to Iwakuni, Japan, with a technical stop in Anchorage, Alaska, and then to the final destination of Hill Air Base, Utah (KHIF). (Operations Factual Report, pages 12-13). The total duty for the three segments was 18 hours 45 minutes with a total block time of 12 hours 43 minutes. (Operations Factual Report, page 13). He remained at Hill Air Base, Utah, for 73 hours 21 minutes before his next flight assignment. (Operations Factual Report, page 13).

On April 27, 2013, he operated as part of an augmented crew (two captains and one first officer) positioning the accident airplane from Hill Air Base, Utah, to Chateauroux, France. (Operations Factual Report, page 13). The total duty was 12 hours 8 minutes with a total block time of 9 hours 32 minutes. (Operations Factual Report, page 13). At Chateauroux, France, the accident captain was off duty for 12 hours 18 minutes before his next assignment. (Operations Factual Report, page 13).

On April 28, 2013, he was scheduled to operate as part of a "heavy" crew of two captains and two FOs flying three segments with a total duty of 25 hours and 4 minutes and a total block time of 14 hours 11 minutes. (Operations Factual Report, page 13). The revised segments would have been from Chateauroux, France to Camp Bastion Airfield, Afghanistan, continuing to Bagram, Afghanistan, then the final leg to Al Maktoum, UAE. (Operations Factual Report, page

13). At the time of the accident, the captain and flight crew had completed the first two segments for a total block time of 10 hours 41 minutes. (Operations Factual Report, page 13). He had checked in at 1400Z on April 28, 2013, and had been on duty for approximately 21 hours at the time of the accident. (Operations Factual Report, page 13).

(b) First Officer

The accident first officer was 33 years old. (Operations Factual Report, page 13). His date of hire with National Airlines was February 23, 2009. (Operations Factual Report, page 13). He transitioned to B747-400 first officer on July 20, 2012, having previously served as a DC-8 first officer. (Operations Factual Report, page 13).

The first officer was current and qualified under National Airlines and FAA requirements. (Operations Factual Report, page 13). A review of FAA PTRS records found no prior accident, incident or enforcement actions. (Operations Factual Report, page 13). A search of records at the National Driver Registry (NDR) found no history of driver's license revocation or suspension. (Operations Factual Report, page 13).

The First Officers' certificate history was as follows:

Private Pilot – Airplane Single Engine Land	Certificate issued 5/26/2008
Private Pilot – Airplane Single and Multiengine Land	Certificate issued 6/25/2008
Private Pilot – Airplane Single and Multiengine Land Instrument Airplane	Certificate issued 8/3/2008
Commercial Pilot – Airplane Multiengine Land, Private Pilot Privileges Airplane Single Engine Land Instrument Airplane	Certificate issued 9/19/2008
Ground Instructor Advanced Instrument	Certificate issued 9/24/2008
Flight Instructor –Airplane Multiengine	Certificate issued 10/1/2008
Flight Instructor – Instrument Airplane Multiengine	Certificate issued 10/4/2008
Commercial Pilot – Airplane Single and Multiengine Land, Instrument Airplane	Certificate issued 10/8/2008
Flight Instructor – Instrument Airplane Single and Multiengine	Certificate issued 10/10/2008 Renewed 10/22/2010; 9/12/2012
Mechanic Airframe, Powerplant	Certificate issued 2/14/2009
Flight Engineer Turbo-jet Powered	Certificate issued 4/17/2009

Commercial Pilot – Airplane Single and Multiengine Land DC-8 (DC-8 SIC Privileges Only), English Proficient	Certificate issued 3/24/2011
Commercial Pilot – Airplane Single and Multiengine Land, Instrument DC-8 (DC-8 SIC Privileges Only, DC-8 Circ Apch – VMC Only), English Proficient	Certificate issued 7/7/2011
Commercial Pilot – Airplane Single and Multiengine Land, Instrument Airplane, B747-400 DC-8 (B747-400, DC-8 SIC Privileges Only; B747-400, DC-8 Circ Apch – VMC Only), English Proficient	Certificate issued 8/8/2012

(Operations Factual Report, page 14).

The First Officer's times were as follows:

Total pilot flying time	1100
Total Flight Engineer time	720
Total Pilot-In-Command (PIC) time	451
Total B747-400 time (SIC)	209
Total flying time last 24 hours	14
Total flying time last 30 days	71
Total flying time last 90 days	140
Total flying time last 12 months	219

(Operations Factual Report, page 15).

The National Airlines B747-400 check airman who provided initial B747-400 simulator training for the accident first officer said the accident first officer's simulator performance was good for a pilot new to the airplane, coming off the DC-8, and he was "very well prepared." (Operations Factual Report, page 13). A B747-400 captain for National Airlines who flew with the accident first officer said the FO's pilot monitoring skills were great, and he was very professional. (Operations Factual Report, page 13). Another captain said the accident first officer had "good flying skills for his low pilot time in general." (Operations Factual Report, page 13).

Prior to departing on his sequence of flying, the accident FO was at his Detroit, Michigan home-base on five days of leave that he had requested from April 3, 2013, to April 7, 2013, followed by eight assigned days off. (Operations Factual Report, page 15). On April 16, 2013, he travelled to Fresno, California, where he had 33 hours 11 minutes off duty before his next flight assignment. (Operations Factual Report, page 15). On April 18, 2013, he operated as part of a "heavy" crew (two captains and two FO's) from Fresno, California, to McGuire Air Force Base, and then continued to Ramstein Air Base, Germany for a total duty of 19 hours 28 minutes and block time of 11 hours 57 minutes. (Operations Factual Report, page 15). He was off duty for 31 hours 02 minutes before his next flight assignment. (Operations Factual Report, page 15).

On April 20, 2013, he operated as part of a "heavy" crew from Ramstein Air Base, Germany, to McGuire Air Force Base, and then deadheaded on the airplane to Rockford, Illinois, for a total duty day of 18 hours 58 minutes and a block time of 8 hours 29 minutes. (Operations Factual Report, page 15). At Rockford, Illinois, he was off duty for 31 hours and 40 minutes. (Operations Factual Report, page 15).

On April 22, 2013, he was part of a "heavy" crew that positioned the airplane from Rockford, Illinois, to Kunsan Air Base, Korea. (Operations Factual Report, page 16). The total duty was 16 hours 01 minute with a total block of 14 hours 08 minutes. At Kunsan Air Base, he was off duty for a total of 20 hours 58 minutes. (Operations Factual Report, page 16).

On April 23, 2013, he was part of a "heavy" crew that operated three segments originating at Kunsan Air Base to Iwakuni, Japan with a technical stop in Anchorage, Alaska, and then to the final destination Hill Air Base, Utah. (Operations Factual Report, page 16). The total duty for the 3 segments was 18 hours 45 minutes with a total block time of 12 hours 43 minutes. (Operations Factual Report, page 16).

The accident first officer remained at Hill Air Base, Utah, for 73 hours 21 minutes before his next flight assignment. (Operations Factual Report, page 16). During that period, he was assigned a 24 hour break on April 25, 2013, and an additional 10 hour rest period from 1430Z on April 26, 2013, to 0030Z on April 27, 2013. (Operations Factual Report, page 16).

On April 27, 2013, he operated as part of an augmented crew positioning the airplane from Hill Air Base, Utah, to Chateauroux, France. (Operations Factual Report, page 16). The total duty was 12 hours 08 minutes with a total block time of 9 hours 32 minutes. (Operations Factual Report, page 16). In Chateauroux, France, he was off duty for 12 hours 18 minutes before his next assignment. (Operations Factual Report, page 16).

On April 28, 2013, he was scheduled to operate a revised schedule as part of a "heavy" crew flying three segments with a total duty of 25 hours 04 minutes and a total block of 14 hours 11 minutes. (Operations Factual Report, page 16). The revised segments would have been from Chateauroux, France, to Camp Bastion Airfield, Afghanistan, continuing to Bagram, Afghanistan then the final leg to Al Maktoum, UAE. (Operations Factual Report, page 16). At the time of the accident, they had completed the first two segments for a total block time of 10 hours 41 minutes. (Operations Factual Report, page 16). He had checked in at 1400Z on April 28, 2013, and had been on duty for approximately 21 hours at the time of the accident. (Operations Factual Report, page 16).

(c) The Loadmaster

The accident loadmaster was 36 years old. (Operations Factual Report, page 16). His date of hire with National Airlines was November 22, 2010. (Operations Factual Report, page 16). The "loadmaster" position is not defined in the Code of Federal Regulations (CFRs), and it is not a certificated position. (Operations Factual Report, page 16). There are no duty time or rest requirements for loadmasters, and there are no training requirements for loadmasters contained in 14 CFR Part 121. (Operations Factual Report, page 16).

According to company records, the accident loadmaster attended loadmaster initial training at National Airlines from December 6, 2010, to December 14, 2010. (Operations Factual Report, page 17). He attended a three day loadmaster recurrent training between December 1 and December 3, 2011. (Operations Factual Report, page 17). Between January 5 and January 9, 2012, the accident loadmaster attended B747-400 training that included a review of a Telair cargo loading DVD, B747-400 aircraft familiarization, and B747-400 weight and balance training. (Operations Factual Report, page 17). In addition, he attended a one day training session on a computerized B747- 400 weight and balance system on May 8, 2012. (Operations Factual Report, page 17).

According to National Airlines, the loadmaster initial training syllabus was a 68 hour course that consisted of the following subjects:

Dangerous Goods training	24 hours
Departmental Policies and Procedures	4 hours
Flight and Cargo Documentation	3 hours
Ground Operations	8 hours
757 Emergency Equipment Training	2 hours
757 Door Training	
757 Ditching	
Ground Security Coordinator Training	4 hours
Passenger Operations security (2 hours)	
Cargo operations security (2 hours)	
Aircraft Familiarization and Weight and Balance	
DC-8	2 hours
B757	4 hours
B747-400 (includes Telair DVD)	12 hours
CRM Training	2 hours
HR Orientation	3 hours
Total Time	68 hours

(Operations Factual Report, page 18).

According to National Airlines, the loadmaster recurrent training syllabus was a 24 hour course that consisted of the following subjects:

Dangerous Goods training	8 hours
Departmental Policies and Procedures	1 hour
Flight and Cargo Documentation	1 hour
Ground Operations	2 hours
757 Emergency Equipment Training	2 hours
757 Door Training	
757 Ditching	
Ground Security Coordinator Training	4 hours
Passenger Operations security	
Cargo Operations security	
Aircraft Familiarization and Weight and Balance	
DC-8	1 hour

B757	1 hour
B747-400 (includes Telair DVD)	2 hours
CRM Training	2 hours
Fundamentals of Instructing (check LMs)	1 hour
Total Time	24/25 hours

(Operations Factual Report, pages 18-19).

On April 26, 2013, the accident loadmaster travelled from Detroit, Michigan (DTW) home base to Hill Air Base, Utah. (Operations Factual Report, page 19). Prior to travel he had several days off in Detroit. (Operations Factual Report, page 19).

On April 27, 2013 the loadmaster showed at the aircraft at 1610Z, and operated a positioning flight from Hill Air Base, Utah, to Chateauroux, France. (Operations Factual Report, page 19). The total duty period was 12 hours 08 minutes with a total block time of 9 hours 32 minutes. (Operations Factual Report, page 19). At Chateauroux, France, he was off duty for 12 hours 18 minutes before his next assignment. (Operations Factual Report, page 19). On the day of the accident, the loadmaster was scheduled to operate the same flight segments as the flight crew, operating from Chateauroux, France, to Camp Bastion Airfield, continuing to Bagram, Afghanistan, and then the final leg to Al Maktoum, UAE. (Operations Factual Report, page 19).

1.3 Aircraft information

The accident airplane (Serial number 25630, Registration N949CA) was a Boeing B747-428 BCF (Boeing Converted Freighter) manufactured February 10, 1993, and registered to Wells Fargo Bank Northwest. (Operations Factual Report, page 20). The airplane was certified in the Transport Category per 14 CFR Part 25 and Part 36. (Operations Factual Report, page 20). According to the National Airlines B747-400 FCOM "Airplane General" the airplane was approved for the following kinds of flight and operation, both day and night, when the required equipment was installed and approved in accordance with the applicable Federal Aviation Regulations:

- Visual (VFR)
- Instrument (IFR)
- Icing Conditions
- Extended Overwater

(Operations Factual Report, page 20).

According to maintenance records, the accident aircraft had one deferred maintenance item on the accident flight for a hydraulic pump removed from the fly away kit (FAK).[1] (Operations

[1] The National Airlines B747 Minimum Equipment List (MEL), page 24, stated the following: Fly Away Kit (FAK) – sometimes called Spare Parts Kit (SPK), a Fly Away Kit is a National Airlines kit of tools, supplies and spare parts placed on the aircraft. The contents of the FAK is

{footnote continued}

Factual Report, page 20).

N949CA was equipped with the Telair International main deck cargo handling system, pursuant to supplemental type certificate (STC) ST00459LA. (Structures Factual Report, page 18). The cargo restraint equipment includes pallet locks, side guide restraints, centerline guide restraints and retractable and fixed end stops. (Structures Factual Report, page 18). The restraining system locks Unit Load Devices (ULDs) against forward, aft, vertical or lateral movement. (Structures Factual Report, page 18). All restraining equipment is equipped with integrated components that support the conveying capabilities of the cargo handling system. (Structures Factual Report, page 18). All restraining equipment is installed in seat tracks, floor fittings, or within other cargo components. (Structures Factual Report, page 18). The Telair manual did not provide for any weight restriction with regard to use of seat tracks. (Interview of Alfredo (Gumby) Gumbs, Operational Factors Attachment 1, page 31).

1.4 NAL/NAC Corporate Organization, Management and Safety Programs

National Airlines began as Murray Air in 1985 as a Part 135 certificate holder headquartered at Willow Run Airport in Ypsilanti, Michigan. (Operations Factual Report, page 57). The company acquired its 14 CFR 121 certificate in 2005 and operates under both Parts 121 and 135. (Operations Factual Report, pages 57-58). In 2000, Daimler Chrysler contracted with Murray Air to operate long-haul freight flights utilizing two DC-8's operated under 14 CFR 125. (Operations Factual Report, page 58). In November 2006, Murray Air, Inc. was purchased by National Air Cargo and renamed National Air Cargo Group. (Operations Factual Report, page 58). The company did business as National Airlines and began to transition its fleet from an all DC-8 cargo composition to a mix of B-747 cargo and B-757 passenger operations. (Operations Factual Report, page 58). The company received FAA approval for passenger operations in June 2011, and hired a corps of experienced flight attendants to begin operations on the B-757. (Operations Factual Report, page 58).

National Airlines' key management personnel have extensive experience in aviation and related business enterprises. Collectively, National Airlines' five FAA Part 119 personnel have over 140 years of experience.

At the time of the accident, National Airlines operated three B-747-400 cargo airplanes and one B-757 passenger airplane. (Operations Factual Report, page 58). According to FAA records, the airline had a total of 230 employees, of which 43 were captains, 35 were FOs, and 13 were check airmen. (Operations Factual Report, page 58). Pilots were typically scheduled for 20 days on, 10 days off. (Operations Factual Report, page 58). Due to the growth of the B757 fleet, National Airlines was hiring at the time of the accident. (Operations Factual Report, page 58). There was no recent hiring or planned hiring, however, for the B747-400. (Operations Factual Report, page 58). The pilots, loadmasters and flight followers/dispatchers were all non-union. (Operations Factual Report, page 58).

{continued from previous page}
aircraft specific and is determined by the Director of Maintenance. The FAK will have a specific location and contents in keeping with weight and balance control.

The National Airlines Part 119 Director of Operations was responsible for airline operations and for the quality of the National Airlines Weight and Balance Program. (Operations Factual Report, page 58). He had the authority to establish and modify the policies, procedures, instructions, and information for the National Airlines Weight and Balance Program process. (Operations Factual Report, page 58). The Director of Operations was also responsible for the quality of the Flight Operations Training Manual. (Operations Factual Report, page 58). He also had the authority to establish and modify that program. (Operations Factual Report, page 58). National Airlines had a System Chief Pilot and two Fleet Managers (757 and 747-400). (Operations Factual Report, page 58). Line Check Airmen reported to the System Chief Pilot through each Fleet Manager. (Operations Factual Report, page 58).

The National Airlines Director of Training and Standards had been in that position since May of 2012, and had been delegated the authority by the Director of Operations to administer the flight operations training program for Pilots, Flight Attendants, and Flight Followers. He also had the final authority as to the content, revision, and distribution of the training program. (Operations Factual Report, page 60). His duties at National Airlines included regulatory compliance and effectiveness for pilot, flight follower, and flight attendant training. (Operations Factual Report, page 60). He had three full-time staff and an additional six or seven pilots on the B757 and B747-400, each who were simulator instructors and check airmen, and flight follower instructors. (Operations Factual Report, page 60). National Airlines conducted B747-400 simulator training at Kalitta Air in Ypsilanti, Michigan and United Airlines in Denver, Colorado, and B757 training in Miami. (Operations Factual Report, page 60).

The National Airlines Part 119 Director of Safety was responsible for SMS implementation, ASAP oversight, FOQA flight data analysis, and a joint responsibility for the security program with the Director of Security. (Operations Factual Report, pages 58-59). He was also a liaison to the Department of Defense (DoD) and their safety program. (Operations Factual Report, page 59). The Safety department consisted of 3 employees; the Director, a safety assurance manager and a flight safety analyst. (Operations Factual Report, page 59).

National Airlines had an ASAP program for the pilots and an online irregularity reporting system. (Operations Factual Report, page 59). According to the FAA Principal Maintenance Inspector (PMI), mechanics were a part of the ASAP program. (Operations Factual Report, page 59).

Pilots and loadmasters could file irregularity reports to report safety issues, and ASAPs could be filed online with the web based access tool (WBAT). (Operations Factual Report, page 59). National Airlines used WBAT for data collection and analysis. (Operations Factual Report, page 59). A pilot seeking to make a report had a number of options, including downloading the form from the company intranet, sending the company an email, or making a phone hotline request. (Operations Factual Report, page 59). National Airlines has never received any ASAP reports or irregularity reports concerning load shifts. (Interview of Carlos Veliz, Operational Factors, Attachment 1, page 42).

According to the National Airlines Weight and Balance Manual (dated October 10, 2012), hiring, training, scheduling and management of loadmasters at National Airlines were the responsibility of the Chief Loadmaster. (Operations Factual Report, page 59). He was also responsible for the evaluation of loadmasters and "check loadmasters," and manually scheduled loadmasters using

an Excel spreadsheet. (Operations Factual Report, page 59). The loadmaster position is not regulated or certificated by the FAA, and at the time of the accident there was no FAA guidance available to loadmasters. (Operational Factors Attachment 8, page 3). There is also no oversight by the FAA for loadmaster performance. (Operational Factors Attachment 8, page 3). In fact, the FAA PMI and POI were unclear as to who had direct oversight over loading operations. (Operational Factors Attachment 1, pages 50, 54, 57).

Despite the lack of such regulatory guidance, National Airlines voluntarily developed a training program based on the chief loadmaster's extensive experience and existing industry best practices. (Operational Factors Attachment 12). The chief loadmaster was also responsible for training ground operations vendors like National Air Cargo the airline procedures at National Airlines. (Interview of Alfredo (Gumby) Gumbs, Operational Factors Attachment 1, page 29). National Airlines' loadmasters provide a report for every load, and these loads are reviewed and discussed during a daily operations meeting that includes the Director of Safety. (Operational Factors Attachment 1, pages 33 and 43). Further, audits of National Air Cargo are conducted at least once a year by National Airlines using standard IATA checklists. (Interview of Alfredo (Gumby) Gumbs, Operational Factors Attachment 1, page 33).

The company has daily operational meetings which include discussion of safety issues. (Interview of Carlos Veliz, Operational Factors Attachment 1, page 43). There is also a safety meeting held approximately once per month. (Interview of Carlos Veliz, Operational Factors Attachment 1, page 43). The Safety Review Board meets quarterly. (Interview of Carlos Veliz, Operational Factors Attachment 1, page 43).

1.5 NAL cargo operation policies and procedures

National Airlines company policies and procedures regarding cargo operations were incorporated in the National Airlines Cargo Operations Manual dated September 25, 2012 (the "Manual"). (Operations Factual Report, page 22). Section 1.2 of the Manual, entitled “Guiding Authorities,” stated in part:

> *This Manual presents the Company Operations and System Control policies and procedures for Carriage of Cargo Operations. These policies and procedures supplement the General Operations Manual and General Maintenance Manual and were developed in accordance with Advisory Circular AC 120-85, IATA Dangerous Goods Regulations, National Airlines Hazardous Materials Manual, Flight Standards Information Management System 8900.1, ATOS Data Collection Tool SAI 1.3.25 Cargo Handling Equipment, Systems and Appliances (AW), ATOS Data Collection Tool SAI 3.1.8 Carriage of Cargo (OP) and all applicable Federal Aviation Regulations (14 CFRs). The procedures and processes contained within this chapter are used to ensure that no aircraft is allowed to take off unless all components of the Cargo Operations program have been executed.*

(Operations Factual Report, page 22).

The Manual was an FAA accepted manual and it complies with the recommendations of AC120-85. (Operations Factual Report, page 22).

The Manual states that its "procedures have been established to maintain control of weight and balance of the Company's aircraft under the terms authorized by Operations Specifications E096 Weight and Balance Control Procedures." Id. at ¶ 1.2. The Manual specifically states that its policies and procedures "were developed in accordance with Advisory Circular AC 120-85 . . . and all applicable Federal Aviation Regulations (14 CFRs)."

Chapter 2 of the Manual includes weight requirements for palletized and bulk cargo. It states that cargo loaded on National Airlines aircraft will be checked for accuracy of weight on a certified scale. Manual at p. 2-18. Center of gravity requirements for pallet loads are set forth at pp. 2-19 and 2-20. A Weight and Balance Loadplanner and a Weight and Balance Trim Sheet specific to the B747 aircraft must be prepared and signed by the National Airlines employee who has the duty of supervising the loading of the aircraft. Id. at p. 3-7.

Chapter 3 of the Manual contains detailed requirements for the loading and unloading of cargo. The Manual notes that "[a]ll cargo operations personnel involved with the loading of an aircraft are required to use the procedures, instructions, and information outlined in this manual," and that "[c]hecklists and forms contained in this manual and the General Operations Manual must be used to control the loading of an airplane." Id. at p. 3-1. Procedures for the loading of the B747 aircraft are specified separately at pp. 3-7 to 3-16.

The National Airlines Weight and Balance Manual, Chapter 2 “Loading Information” page 2-3, stated in part:

> *The Preparer/Agent completes the following on the form:*
> - *Date*
> - *Aircraft*
> - *Flight Number*
> - *Gross Weight*
> - **Pieces*
> - **Net Weight*
> - *Destination*
> - **Customer*
> - *ULD Number*
>
> **Denotes completion of this item may be done after loading as this pertains to down line destinations and tracking. In completing the form the planner will ensure the aircraft will operate within approved limits of the center of gravity. After completion of this form the Agent will sign the form and brief the Flight and Ramp Operations Manager Down Line Destinations or Loadmaster with any special loading requirements.*

(Operations Factual Report, pages 22-23).

National Airlines used National Air Cargo in Dubai, UAE (Dubai World Central) for load planning, cargo/pallet build up, and aircraft loading of the National Airlines B747-400. (Operations Factual Report, page 23). There were four load planners in Dubai, and two were “approved” by National Airlines, and the load planners were certified by ICAO standards. (Operations Factual Report, page 23).

The National Airlines Weight and Balance Manual, Chapter 2 "Loading Information" page 2-1 stated in part:

> *The National Airlines Load Supervisor (Loadmaster) or qualified representative is responsible for the acceptance of all cargo planeside, and that all ULDs and pallets are properly identified and tagged in accordance with the COM [Cargo Operations Manual] requirements. The load supervisor is also responsible for verifying the aircraft is loaded and cargo weights checked for accuracy in accordance with the loading manifest provided by the National Airlines OCC. This verification is essential to ensure weight and balance calculations previously performed by National Airlines OCC are valid.*

(Operations Factual Report, page 23).

In addition, the National Airlines Cargo Operations Manual, Section 1.8.3 "Load Supervisor," page 1-7, stated in part:

> *For the purpose of this manual, the title Load Supervisor can be interchanged with Plane Side Representative, Experienced Cargo Handling Personnel, Loadmaster, Mechanic or Flight Engineer. The Loading Supervisor is responsible for:*
>
> *• Reviewing the location of any missing restraint (Beartrap, side lock etc.) and advising maintenance for any corrections.*
> *• Confirm load and proper ULD contour.*
> *• Confirm Proper tie down.*
> *• Reject any damaged pallets and nets or correct to meet Company requirements and standards.*
> *• Pallet, container and nets should be examined by the Loading Supervisor for gouges, depressions, delaminated panels, cracked edge rails, bowing, and missing corners and rivets to meet Company requirements and standards.*
> *• Confirm Number*
> *• Tail Stand and tail post are being properly used.*
> *• Visually inspect the Aircraft for possible damage caused by ground support equipment*
> *• Signs appropriate Load Planning Sheet after loading completed verifying that the aircraft was loaded according to the Load Planning Sheet and I/A/W Company loading requirements, and that all locks, in the pallet positions, are properly installed and in the pallet locked position. The original copy of form will be returned to the Cargo Operations Agent for the Company principal base of operation or down line destination, as applicable, file and a signed copy will be given to the crew. The PIC of the flight must carry in the aircraft to its final destination the signed copy of the load manifest. This will be placed with the trip paperwork which must also include at a minimum, the flight release, airworthiness release, pilot route certification and the completed flight plan that the PIC is responsible for obtaining. If needed see additional information for the required trip paperwork in the GOM.*

(Operations Factual Report, pages 23-24).

National Airlines employed 13 loadmasters and three check loadmasters. (Operations Factual Report, page 24).

The responsibilities for Load Operator were defined in the National Airlines Weight and Balance Manual, Chapter 2 "Loading Information" page 2-4, which stated in part:

> *Responsible for the positioning and operation of cargo loader for transfer of freight to the aircraft. In performing this operation the loader operator:*
>
> *1. Verifies the position number on the appropriate Load Planning Sheet.*
> *2. Checks proper sequencing of the load, position #1 loaded first then aft positions.*
> *3. If trained and qualified, he may also perform the responsibilities of the Loading Supervisor.*

(Operations Factual Report, page 24).

The responsibilities for forklift operators or pallet transport operator were defined in the National Airlines Weight and Balance Manual, Chapter 2 "Loading Information" page 2-4, and stated in part:

> *Responsible for movement of freight to aircraft for loading.*
>
> *1. Positions ULD's on loader for main deck loading. When using a forklift equipped with a scale, he may verify weights as indicated on Pallet Tags. In the event of a variance of (+/-) 300 pounds, the Load Preparer and or Loading Supervisor will be notified.*

(Operations Factual Report, page 24).

In Chapter 6 of the Manual, shoring requirements are set forth as follows:

> *4.5 SHORING REQUIREMENTS*
> *Shoring is used to spread highly concentrated loads over a greater base area than that occupied by the cargo alone. Use of shoring permits carrying a load with a higher concentration than would be normally allowed. It is also used to protect ULD[2] surfaces from damage caused by vehicle cleats, steel wheel rims, and packing case studs or protrusions. Cargo exceeding the rated floor bearing capacity of a ULD or aircraft will require shoring to distribute the load over a greater area. Shoring used for weight distribution may be ordinary planking laid beneath the cargo, or it may be composed of plywood sheets.*

Id., Chapter 6, pp. 6-11.

The Manual, Section 5.10 "Shoring" also stated in part:

[2] A unit load device (ULD) is a pallet or container used to load luggage, freight, and mail on wide-body aircraft and specific narrow-body aircraft.

Shoring can become necessary for heavy (typically over 2000 lb./1000 kg) concentrated loads in order to meet either the applicable aircraft area load or running load limitations, or both.

Note: *At least elementary shoring can also become necessary for practical reasons, even in instances where neither the area load or the running load limitations are exceeded, on a plate aluminum AS1491B (ISO 4171, IATA 50/1) type pallet in order to avoid local deformation which might render it difficult to move on rollerized conveyors. For example, an automobile directly loaded onto such a pallet usually does not exceed either limitation. Yet its wheels will create local base sheet deformation, which should be avoided by placing sufficiently stiff material, e.g. thick and long enough planks, below each wheel -unnecessary precaution with a heavy duty pallet.*

Accordingly, shoring can be performed either laterally in relation to the aircraft centerline (area load limitation), or longitudinally (running load limitation), or both simultaneously .

Pallet tiedown procedures are set forth at pp. 2-25 to 2-34. The Manual includes specific tie-down methods and strap requirements. The required number of straps are listed, but the actual amount used may be in the discretion of the loadmaster. National's practice at the time of the accident was to calculate the number of straps to be used as follows:

1. Multiply the weight of the item by the load factor applicable. (Fwd 1.5, Aft 1.5, Lateral (left and right) 2.0 and Vertical 2.5)
2. Divide the rated capacity of the strap by 75%. i.e., 5,000 Lbs. strap capacity would be 3,750 Lbs.
3. Take the sum of the weight multiplied by the load factor and divide by 3,750 Lbs. to get the number of straps needed.
4. Always round up to the next even number of straps if the number is an odd number of straps. Always round up to the next even number of straps if there is a number passed the decimal point.

At the time of the crash the FAA had not mandated compliance with the minimum requirements of TSO-C172 with respect to strap quality. However, the National Manual had already implemented these requirements and others found in ISO 16049-1, SAE AS 5385A, IATA UTM60/2 before the April of 2016 deadline.

National Airlines uses actual weights and not average, assumed or estimated weights for tendered cargo. Id. The Loadmaster, Flight Crew, Load Supervisor, or other National Airlines authorized loading agent are responsible for ensuring that scales used to weigh cargo loaded on company aircraft are within its calibrated interval except for scales located on military installations. Id. at p. 4-11. In accordance with AC 120-85 National Airlines conducts periodic audits of calibration of scales to ensure they are appropriately serviced and accurate to a known standard. Id. Calibration records should show that scales are calibrated in accordance with a standard established by the appropriate country, state, or local government regulations, or an equivalent standard acceptable to the FAA. Id. National Airlines has procedures to ensure that scales used for weighing cargo undergo a functional check between scale calibrations. Id.

The Manual provides that damaged pallets, nets, and any other restraint equipment will be removed from service and returned to its proper owner for appropriate action, such as repair by qualified personnel. Id. at p. 2-12. Damage tolerances for both nets and pallets are set forth at pp. 2-13 and 2-14.

Training is addressed in Chapter 7 of the Cargo Operations Manual. It applies to non-crewmenber Loading Supervisors, Ground Handling Personnel, and Operations Controllers. Training is required for any individual who determines the serviceability of ULDs, handles hazmat or frangible load requirements, determines cargo loading system maintenance, performs repair of ULDs and cargo restraint systems, performs receiving inspections for contractor repaired ULDs, is responsible for the operator's records requirements, supervises aircraft cargo handling, and is responsible for ULD build-up and aircraft loading. Id. at 7-1.

The Cargo Operations Manual includes a Loadmaster Checklist, which covers, among other areas, activities involving pre-departure, preparation for loading, loading, after loading and before takeoff, after takeoff, and inflight. This is a paper product that is laminated and available on the aircraft for the Loadmaster. The Manual notes that "[f]ollowing the checklist is a very critical procedure in completing all areas of [the Loadmaster's] duties.

The National Airlines Weight and Balance Manual, Chapter 2, Section 1, page 2-1 "Aircraft Loading Procedures" stated in part:

> *The National Airlines Load Supervisor (Loadmaster) or qualified representative is responsible for the acceptance of all cargo planeside, and that all ULDs and pallets are properly identified and tagged in accordance with the COM requirements. The load supervisor is also responsible for verifying the aircraft is loaded and cargo weights checked for accuracy in accordance with the loading manifest provided by the National Airlines OCC. This verification is essential to ensure weight and balance calculations previously performed by National Airlines OCC are valid.*

Loadmasters were responsible for the weight and balance of the aircraft during the pre-planning stages of the flight in accordance with manufacturer limitations. (Interview of Alfredo (Gumby) Gumbs, Operational Factors Attachment 1, page 29). Loadmasters inspected cargo and pallets, ensured strap and pallet limits were not exceeded, loaded in accordance with the aircraft, and ensured the items were secured properly with the provided restraints or supplemental restraints. (Interview of Alfredo (Gumby) Gumbs, Operational Factors Attachment 1, page 29). Loadmasters notified the captain of any hazmat or dangerous goods locations. Id. at 10.4.4, pages 10-26. Loadmasters also served as ground security coordinators. (Interview of Alfredo (Gumby) Gumbs, Operational Factors Attachment 1, page 29).

Following the loading process, and prior to takeoff, loadmasters were required to deliver the completed weight and balance to the captain and first officer. Id. at 10.4.4, pages 10-26. The paperwork delivered to the crew included the zero fuel weight (ZFW), the MAC% (mean aerodynamic chord), the takeoff power setting and the stabilizer trim setting. (Interview of Reid Sutherland, Operational Factors Attachment 1, page 21). The pilots would then complete the "PERF DATA" page in the flight management computer (FMC) using that information. (Interview of Reid Sutherland, Operational Factors Attachment 1, page 21). The zero fuel weight

was entered in the "PERF INIT" page, and takeoff speeds (V-speeds) would be generated by the FMC. (Interview of Reid Sutherland, Operational Factors Attachment 1, page 21).

Loadmasters were specifically required to check the cargo before departure to ensure all the nets, straps and chains were tightened. (Operations Factual Report, page 74). Loadmasters would typically walk through the main deck with the loading supervisor prior to departure. (Operations Factual Report, page 74). Any items that were found to need additional restraint were required to be secured before departure. (Operations Factual Report, page 74). According to the Manual special attention would be paid to items loaded on top of nets, pipes and small items. (Operations Factual Report, page 74). All loose items were required to be secured before the aircraft blocked out. Documents required to be onboard the airplane prior to the L1 door closing included the following:

- Cargo Manifest
- AirWay bills
- Permits to Proceed (If applicable)
- Shipper's Declarations for Dangerous Goods (Hazmat)

(Operations Factual Report, page 74).

The station copies of the flight paperwork were required to be left with the ground handler or station representative. (Operations Factual Report, page 74). If Dangerous Goods were on the aircraft, a scanned copy or photo of the NOTOC was required to be sent to National Airlines OCC. (Operations Factual Report, page 74). The following documents should be left behind at the departure station:

- A copy of the Flight Release
- A copy of the Weight and Balance
- A copy of the Load plan if not included on the Weight and Balance

(Operations Factual Report, page 74).

During flight, if the cargo onboard was transiting the next airport, the loadmaster would update the next load plan to reduce time at the next airport. (Operations Factual Report, page 75).

National Airlines' use of loadmasters to assess and address risks associated with loads in lieu of formalized risk analyses was consistent with industry standards, although there was no regulation or FAA guidance in that area.

In general, loadmaster procedures were fully consistent with internal training and the FAA-approved Cargo Operations Manual, as well as with industry standards. In particular, the securing of center-loaded pallets to seat tracks rather than side rails, using all available tie down points, as occurred during the subject flights, was consistent with standard industry practice.

1.6 Crew scheduling and rest requirements.

National crews were scheduled thirty days in advance and bid two months at a time. (Interview of Mike Vollmer, Operational Factors Attachment 1, page 47). Scheduling was done in blocks

of 20 days of duty time and 10 days off. (Operations Factual Report, page 58). Crew scheduling constantly reviewed the last 24 hours and the next 72 hours to help shorten duty days and manage fatigue risk. (Operational Factors Attachment 1, pages 45, 47). Seven crew schedulers were available 24 hours a day. (Interview of Mike Vollmer, Operational Factors Attachment 1, page 47).

2. Investigation and Analysis

2.1 General Investigation Summary

2.1.1 Security Issues

The accident occurred in an active war zone and theatre for Operation Enduring Freedom. Both NATO and the United States had combat missions in the country. The inbound flight to Camp Bastion had been delayed by indirect fire from the Taliban. (Operations Factual Report, page 7). The purpose of the accident flight was to move Mine Resistant Ambush Protected vehicles of the U.S. military from Bagram, Afghanistan, to Dubai.

After the flight, the Taliban took credit for the tragedy. The Taliban further threatened the investigator-in-charge for Afghanistan's Ministry of Transportation and Civil Aviation (MoTCA) to coerce him into accepting the Taliban's claim. Although the details surrounding his death are unknown, the investigator-in-charge was subsequently killed.

The starting point for the investigation should have been to eliminate the possibility of terrorism. This possibility is more than theoretical. According to National Air Cargo's Vice President of Ground Operations, not long after the April 29 accident flight an Improvised Explosive Device (IED) was found by a National Air Cargo employee on an armored cargo truck shipped by the military out of Afghanistan to a National Air Cargo facility in the UAE where such vehicles went through a thorough decontamination wash. Although it was later determined that the IED was not a live device, the fact the device went undetected through security sweeps out of Afghanistan and into the UAE lends support to the view that terrorism should not have been discounted in the accident investigation.

The investigation, however, failed to rule out the possibility of terrorism. The following basic investigative actions were not taken following the accident to rule out the potential terrorist claims:

1. Determining whether the military conducted a security sweep of the MRAPs prior to loading.

2. Determining the security situation on the ground during the two hour loading delay before the Atlas loader began loading the Cougars. (National Airlines uses a Security Checklist, which is signed by the loadmaster and carried on board the aircraft; this document was not recovered.)

3. Testing items recovered from the runway following the accident in the vicinity of Taxiway C, which was near the point of takeoff rotation, and items found along

the flight path, for explosives. (Although bomb-sniffing dogs were used after the accident, dogs cannot detect the residue of a bomb that has detonated.)

4. Determining the source of fluid/smoke observed by witnesses during the aircraft's brief flight.

5. Analyzing the CVR to detect the audio signature of an explosion.

The NTSB Operations Group arrived on site on May 2, 2013, and began documenting the wreckage on May 3, 2013. (Operations Factual Report, page 5). Debris was found on the runway and the surrounding environment, but no GPS coordinates were assigned to the debris. Since no measurements were taken of where runway debris was found, the exact position and sequence of parts coming from the aircraft could not be determined. As stated previously, an analysis of these parts was not accomplished to determine the existence of explosive material.

2.1.2 Accident Debris Field

The approximate size of the debris field and the relative location of some of the items found within it could be determined from an aerial survey.

The airplane impacted the ground about 590 feet northeast of the departure end of runway 03. (Structures Factual Report, page 8). According to an aerial survey done by the U.S. military on May 1, 2013, the debris field was 425 feet long. Using the identified aerial reference point 219 behind the APU housing and west of the main crash/fire to point 204, which is 70 feet east of point 7 (cockpit wreckage), the width of the debris field is 421 feet using aerial reference points 355 to the north of the main wreckage/fire area, to point 533 to the south on the same drawing (sheet 2 of 2) for a calculation of 178,925 square feet. The airplane forward of about body station (STA) 2060 (Figure 1) located in section 46 was highly fragmented and consumed by fire. (Structures Factual Report, page 8). Airplane debris was recovered about 4,500 feet downwind from the departure end of runway 03 in the vicinity of taxiway Charlie. (Structures Factual Report, page 8). Six pieces of structure were recovered in the area of taxiway Charlie, three were identified as being located aft of the aft pressure bulkhead (APB) and one was identified as being from the E8 rack containing the cockpit voice recorder (CVR) and flight data recorder (FDR) located forward of the APB and aft of the L5 door on the left hand side (pilot) of the airplane. (Structures Factual, Figure 51, page 38).

During the post-crash field investigation a crane was used to lift wreckage from the debris field. It was observed that the crane rolled over other pieces of wreckage within the debris field thus possibly damaging or burying physical evidence. Some wreckage was hauled in the back of pickup trucks to a parking lot on Bagram Air Base. There was no chain of custody for the wreckage. Moreover, although the military had posted guards, numerous individuals, such as persons bringing flowers to the wreckage and first responders, had access to the wreckage.

None of the four other MRAP vehicles were documented within the debris field. While there was significant impact and fire damage forward of the last recovered MRAP and aircraft tail section, the lack of any attempt at documentation hampers the analysis on the potential for explosives or movement of these vehicles during the brief flight.

2.1.3 Post Crash Witness Marks and Metallurgical Analysis

During the investigation, the aft M-ATV was substantially damaged but not consumed by fire. (Structures Factual Report, page 30). Pieces of the main deck interior panels were recovered from inside the M-ATV and orange and green paint was found. (Structures Factual Report, page 30). Although these were visually similar to the orange paint on the CVR and the FDR cases, and the green primer used on unpainted airplane structures appeared to match the green paint on the rear portion of the aft M-ATV, the presence of paint markings on the vehicle prior to loading, or paint transfer from an item not recovered in the wreckage, were not eliminated as possibilities. A paint analysis to verify that paint was transferred from one surface to another was not completed because there was insufficient paint to provide an adequate sample.

Further, the markings do not show when the impact occurred or the direction of travel of the surfaces on which the paint was found. (See Section D.7 Structures Factual, page 30 and Materials Laboratory Factual Report, 15-02, page 2).

70 total sections of strapping were recovered aft of the last MATV and were torn at varying lengths. (Structures Factual Report, page 35). Twelve 5,000 LB straps of varying length were found attached to 6 sections of the cargo system side guide rail. (Structures Factual Report, page 35). Three straps were attached to seat tracks. (Structures Factual Report, page 35). The straps were submitted to the NTSB Material's Laboratory for examination but no testing was done to rule out explosives. (Materials Laboratory Factual Report 14-066). No explanation was provided in support of a theory that the MATV somehow tore through all the straps.

Multiple sections of the main deck interior panels had evidence of contact with an MRAP tire but the timing and direction of the contact could not be confirmed. (Structures Factual Report, page 41). The most aft MRAP was 96 inches wide. The aircraft at the APB is only 111 inches wide. For the MATV to be in line with the APB liner, it would have to be positioned almost entirely on the left side of the aircraft. (See Figure 73, Structures Factual, page 50). If positioned on the left hand side, 31.5 inches of the vehicle would have been outside the aircraft.

In a centerline load, the tire witness marks would have been centered right of the APB liner vertical center, not left. Based on the position of the witness marks and the centerline location, the MRAP would have had to move to the left to leave the tire imprint. The last valid roll angle was recorded when the FDR stopped recording and the aircraft was at 33 feet AGL. The roll angle was +4 degrees right with a right lateral acceleration, and the aircraft heading is to the right as is the ground track. (FDR Factual Report). Accordingly, the MRAP would have been pushed to the left side of the APB liner (looking aft), not to the right by the dynamic forces acting on the aircraft.

Thus, it appears the contact between the most aft MRAP and the APB was a consequence of the accident crash sequence itself or an explosion inside the aircraft. The aluminum APB was not inspected for loads that explosives might have put on the metal. The post-accident witness marks do not support a theory that the aft most MRAP broke free moving aft as it was loaded on the centerline and the aircraft dynamics of the flight would have pushed the last MRAP to the opposite side of the aft fuselage during takeoff and climb. There is no evidence the seat track restraints failed and no inspection was done to determine if the witness marks were made by rubber. These witness marks can just as likely be explained as resulting from the impact

sequence as the tail section of the aircraft moves forward, impacting the aft MRAP causing the witness marks.

In addition, the imprint of the spare tire on the APB liner does not support an inference that some part of the MRAP contacted the horizontal stabilizer jackscrew collar fitting. The witness marks on the APB liner were not matched to anything on the MRAP other than the spare tire. The source of the witness marks on the horizontal jackscrew collar fitting was not identified through metallurgical analysis, the horizontal stabilizer was not subjected to metallurgical examination, and the effect of vehicle weight on the portion of the stabilizer connecting to the fuselage was not analyzed.

Although an MRAV antenna was found on the runway and the FDR/CVR bracket is in the higher area of the interior, the rest of the parts found were from the lower part of the aft pressure bulkhead (5-6 o'clock position).

All measurements of the MATV were taken with the tires at normal inflation pressure, however, the tires were deflated prior to loading for shoring purposes. Also, the height of the pallets was not considered. As a result, the measurements do not help determine the accident sequence or the cause of the accident.

In addition, possible contact between one of the 238.5 inch aluminum pallets that the MRAPs were secured to and the cargo floor restraints was not substantiated by a lab test, and does not indicate whether movement occurred before or after ground impact.

2.1.4 Weather Conditions

As noted in the Boeing Simulation/FDR Study, page 3, weather observations noted an air mass change which resulted in a 7 knot temperature decrease and a wind magnitude change to 360 degrees true north at 11 knots gusting to 17 knots. Witness Joshua Mullennix (page 36 of the Witness Summary) indicated that Bagram Airfield had been under a weather watch with wind gusts to 45 knots and lightning within 5 miles of the airfield. Also several witnesses noted differing engine noises. (Operational Factors – Attachment 1, pages 7, 15, and 18). With the unusual attitude experienced by the aircraft, along with the gusting wind conditions, the potential for engine compressor stalls exists. This possibility, along with the effect of the wind magnitude change and gusting conditions, was not reviewed during the investigation, nor was it accounted for in the simulation analysis conducted by Boeing.

2.1.5 FDR and CVR Post Crash Evidence

The Operations, FDR and CVR Factual Reports allude to the recorders stopping at the same time. This is contradicted by the recorded information. The last recorded, valid information from the FDR was recorded at 10:56:45 (UTC). The end of the CVR Recording was noted in the CVR Factual Report (page 29) at 10:56:47. Evidence indicates that the FDR continued to record data for another 3.5 seconds after the CVR stopped recording, but the data synchronization was lost. As a result, the actual parameter information could not be recovered (Boeing FDR Data Study, page 4).

In order for the theory that the aft most MRAP separated from its moorings, shifted aft, and struck the CVR installation rack to be true, both recordings must stop simultaneously. Since it appears the FDR recording continued for a substantial time after the CVR stopped, this theory cannot be correct.

2.2 Cargo Loading Operations Conformed to Industry Practice

National Airlines met or exceeded applicable regulations and conformed to industry practices in a number of ways. National Airlines relied on loadmasters to ensure proper loading and weight and balance, used a Unit Loading Department to coordinate strap and chain inventory, and inspected loads in compliance with IATA standards. It developed a comprehensive loadmaster training program, used double pallets and shoring for heavy loads, and used seat tracks to secure center-loaded vehicles.

As demonstrated in Section 2.1, above, there is no evidence that a cargo shift caused a loss of control. Nor is there any evidence pallets were built incorrectly or the vehicles were shored incorrectly.

At the time of the accident, National Airlines employed 16 loadmasters, including 3 check loadmasters, all of whom were qualified on the 747.

2.3 Flight Crew Was Well-Trained

There is no evidence that pilot training was a factor in this accident. National Airlines maintains an FAA approved training program and curricula for crewmembers. All crewmembers must be trained prior to being assigned to any position or performing their required duties. The National Airlines Flight Operations Training Manual (FOTM) describes the pilot training program and is used as a guide to ensure that we meet all training requirements for training pilots, flight instructors and check airmen. All National Airlines personnel must comply with applicable regulations and company policies.

2.4 Flight Crew Scheduling Complied with Regulations

There is no evidence that flight crew training or scheduling were factors in this accident. The accident captain received three full days off duty (73 hours, 21 minutes) leading up to his assignment to the augmented crew (two captains and one first officer) that positioned the accident airplane from Hill Air Base, Utah, to Chateauroux, France, on April 27, 2013. (Operations Factual Report, page 13). The total duty time for that flight was 12 hours 8 minutes. (Operations Factual Report, page 13). At Chateauroux, France, the accident captain was off duty for 12 hours 18 minutes before his next assignment. (Operations Factual Report, page 13).

On April 28, 2013, the accident captain began a duty period of 25 hours and 4 minutes. (Operations Factual Report, page 13). At the time of the accident, the captain had been on duty for approximately 21 hours, with a total block time of 10 hours, 41 minutes. (Operations Factual Report, page 13). The segments flown include Chateauroux, France, to Camp Bastion Airfield, Afghanistan, and from Camp Bastion to Bagram. (Operations Factual Report, page 13). The accident flight segment was from Bagram to Al Maktoum, UAE. (Operations Factual Report, page 13).

The accident first officer, after a 10 hour rest period at Hill Air Base, Utah, that concluded on April 27, 2013, operated as part of an augmented crew positioning the airplane to Chateauroux, France. (Operations Factual Report, page 16). The total duty period was 12 hours 08 minutes with a total block time of 9 hours 32 minutes. (Operations Factual Report, page 16). At Chateauroux, France, he was off duty for 12 hours, 18 minutes before his next assignment, which consisted of flying with the accident Captain to Camp Bastion and then to Bagram, described above. (Operations Factual Report, page 16).

Accordingly, neither crew member was scheduled to be on continuous duty for more than 30 hours, and neither had been on continuous duty for more than 24 hours at the time of the accident. Further, the accident aircraft had an approved rest facility, and National Airlines used augmented flight crews, so the first officer and captain could receive rest while aloft. (Operations Factual Report, page 9). As such, National Airlines was in full compliance with 14 CFR 121.523. (Operations Factual Report, page 9). Further, as noted above, both crewmembers had lengthy off duty periods before the accident trip from Chateauroux, France, commenced. (Operations Factual Report, pages 12-16).

2.5 Flight Crew Actions Did Not Cause the Accident

The flight crew experienced a rapid pitch up almost immediately after liftoff from Bagram. There is no evidence that any actions by the flight crew contributed to the pitch up of the aircraft or the inability of the aircraft to recover from the stall condition. The loss of the CVR and FDR information immediately after liftoff hampered the analysis of the post-accident departure aircraft profile.

2.6 National Airlines' General Safety Culture is Robust

There is no evidence that National Airlines' safety culture was a factor in this accident. Safety issues were discussed daily during meetings that included the Part 119 Director of Safety, and a Safety Review Board met on a quarterly basis. The airline used numerous channels for reporting safety issues, including ASAP and irregularity reports that could be filed with pilots and loadmasters. At the time of the accident, the airline had a FOQA program and was implementing SMS.

National Airlines also voluntarily developed a loadmaster training program despite the absence of regulatory requirements or guidance in the area. National Airlines' loadmasters provided a report for every load, and the reports were reviewed and discussed during a daily operations meeting that included the Director of Safety. Further, National Airlines audited National Air Cargo at least once a year using standard IATA checklists.

Since the accident, National Airlines has adopted the following process improvements to further increase its safety margin:

1. The Cargo Operations Manual (COM) has gone through a major overhaul. COM has incorporated restraint information from both the Boeing and Telair Weight & Balance and Load Control Manual, including:

- Identifying approved tie-down points on Telair components and their limitations
- Listing restraint values for straps connected to seat tracks and other floor components
- Noting differences between the Boeing and Telair strap value charts
- Implementing a manual worksheet to determine total restraint value per direction
- Adding requirements pertaining to Tall Rigid Cargo and determining forward limits
- Defining approved Unit Loading Devices (ULDs)
- Treating un-netted pallets as un-approved ULDs
- Treating T-2 (coupled military 463L pallets) as un-approved ULDs
- Treating pallets with CG outside pallet limits as un-approved ULDs
- Noting center load linear limits

2. Several Loadmasters have attended formal training at the Boeing Performance Engineering course. National Airlines is planning to send 4 LMs per year to all three courses to further each LM's knowledge.

3. National Airlines has advocated and assisted within NACA and Boeing's working groups to standardize the cargo industry with respect to aircraft manufacturer guidelines.

4. National Airlines has created a Special Loads Team to evaluate possible loads offered for airlift, including pre-planning tie-down, shoring and special handling equipment.

5. National Airlines has produced training material for crews to identify possible problems with cargo loaded on the aircraft.

6. National Airlines has clearly defined when audits and training are required and use of LM and Vendor training outlines and PowerPoint presentations.

7. GMM Chapter 9 was created to address ULD and strap airworthiness, serviceability procedures for the acceptance of ULDs plane side, including the cargo loading systems and associated ULD airworthiness requirements for each make, model and series of aircraft operated by National Airlines. A description along with instructions and information for cargo loading ground operations is located in the National Airlines Cargo Operations Manual.

As a supplemental carrier, National Airlines does not own any ULDs, Pallets, Nets or Straps. However all ULDs, Pallets, Nets, and Straps undergo an acceptance check by the Load Supervisor or Load Master for serviceability prior to being loaded aboard the aircraft. The acceptance check instructions and procedures are contained in the Cargo Operations Manual. In the event that National Airlines was to purchase its own ULDs, Pallets, Nets or Straps the processes, procedures and controls contained in this chapter have been put in place to ensure the

airworthiness of these items. Also included is information to provide instructions for the maintenance, preventive maintenance, alterations and preservation of National Airlines' cargo handling equipment, systems, and appliances. These policies and procedures also provide a program for the inspection and maintenance of Unit Load Devices (ULDs) by National Airlines maintenance, or maintenance designees.

8. Training was created to inform maintenance and load master personnel of the conditions and limits for cargo handling equipment referenced in GMM Chapter 9.

9. An FCD was created to clearly identify seat track usage in accordance with Boeing's Weight and Balance Manual. The seat tracks on the MCD are clearly identified with either a red or green painted stripe adjacent to the track, indicating whether or not it is an acceptable location to accept load bearing straps.

3. Probable Cause

The probable cause of the accident was a departure stall at an altitude that was too low to allow for recovery. The cause of the pitch up and departure stall could not be determined due to the loss of the FDR and CVR information immediately after liftoff and the destruction of the wreckage following impact and post-crash fire. Terrorist activity, such as explosive damage or sabotage to the aircraft or its cargo, cannot be ruled out.

END