National Transportation Safety Board
Aviation Accident Final Report

Location:	Minneapolis, MN	**Accident Number:**	CHI05MA111A
Date & Time:	05/10/2005, 1936 CDT	**Registration:**	N763NC
Aircraft:	McDonnell Douglas DC-9-51	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	1 Serious, 6 Minor, 95 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

The DC-9 was taxiing to the gate area when it collided with a company A-319 that was being pushed back from the gate. Prior to arriving at the destination airport, the DC-9 experienced a loss of hydraulic fluid from a fractured rudder shutoff valve located in the DC-9's right side hydraulic system. The left side hydraulic system had normal hydraulic pressure and quantity throughout the flight. The flightcrew elected to continue to the scheduled destination and declared an emergency while on approach to the destination airport. After landing, the emergency was negated by the flight crew and the airplane taxied to the gate. Flight data recorder information indicates the left engine, which provides power for the left hydraulic system, was shut down during taxi. The captain stated he did not remember shutting the left engine down, and that if he had, it would have been after clearing all runways. The first officer stated that he was unaware that the left engine was shut down. Upon arrival at the gate with the left engine shut down and no hydraulic pressure from the left system and a failure of the right hydraulic system, the airplane experienced a loss of steering and a loss of brakes. The flightcrew requested company maintenance to chock the airplane since they were unable to use brakes to stop the airplane. The crew said they were going to keep the "...engines running in case we have to use reversers..." The airplane began to roll forward and the captain applied reverse thrust but the reversers did not deploy. The airplane impacted the A-319 with a speed of approximately 15.65 miles per hour to 16.34 miles per hour. Evacuation of the DC-9 was completed approximately 5:22 minutes after the collision and evacuation of the A-319 occurred approximately 13:08 minutes after the collision. Examination of the left hydraulic system revealed no anomalies and examination of the right hydraulic system revealed a fractured rudder shutoff valve that displayed features consistent with fatigue. Following the accident, the airplane manufacturer issued a service letter pertaining to the replacement of the rudder shutoff valve based upon reliability information that was reported to them. The number of reports was greater than that of the Federal Aviation Administration's Service Difficulty Reports database, and less than the operators records.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: the Captain's decision to shutdown the left engine during taxi with no hydraulic pressure on the right side hydraulic system to effectively operate the brakes, steering, or thrust reversers. A factor was the fatigue fracture of the rudder shutoff valve which resulted in the loss of right side hydraulic pressure.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation: CLIMB - TO CRUISE

Findings
1. (F) HYDRAULIC SYSTEM,SHUTOFF VALVE - FATIGUE
2. HYDRAULIC SYSTEM - FAILURE

Occurrence #2: ON GROUND/WATER COLLISION WITH OBJECT
Phase of Operation: STANDING - ENGINE(S) OPERATING

Findings
3. (C) ENGINE SHUTDOWN - INCORRECT - PILOT IN COMMAND
4. (C) PLANNING/DECISION - IMPROPER - PILOT IN COMMAND

Factual Information

HISTORY OF FLIGHT

On May 10, 2005, at 1936 central daylight time, a McDonnell Douglas DC-9-51, N763NC, collided with an Airbus A-319-114, N368NB, during taxi into the gate resulting in substantial damage to both airplanes near gate G10, at Minneapolis/St. Paul International Airport (MSP), Minneapolis, Minnesota. Both airplanes were operated by Northwest Airlines Inc. (NWA) under Title 14 Code of Federal Regulations (CFR) Part 121 as scheduled-domestic passenger flights 1495 (N763NC) and 1849 (N368NB). Visual meteorological conditions prevailed at the time the accident. Both airplanes were evacuated after the collision. The DC-9 captain (CAPT) received serious injuries and the first officer (FO), two flight attendants (FAs) and two passengers received minor injuries. Three A-319 FAs and one passenger received minor injuries. Three NWA ground personnel received minor injuries. N763NC departed Port Columbus International Airport (CMH), Columbus, Ohio, at 1826 eastern daylight time with a scheduled destination to MSP.

The following are excerpts from the Operations Group Chairman and DC-9 Cockpit Voice Recorder (CVR) Group Factual Reports. The CVR transcription contains recordings of the CAPT, FO, cockpit area microphone (CAM), radio transmissions from the CAPT (RDO-1) and FO (RDO-2), NWA maintenance control (MAINT), and MSP Air Traffic Control Tower (ATCT).

The DC-9 CAPT stated that the accident occurred on the second leg of a two-day trip. The first leg from MSP to CMH was uneventful.

The FO was the flying pilot on the return flight from CMH to MSP. The FO stated that the departure from CMH was normal except that they had to use five degrees of flaps for takeoff because of the airplane's heavier weight. After takeoff, at some point below 4,000 feet altitude, when the slats were retracted, the MASTER CAUTION light illuminated. He observed the RUDDER CONTROL MANUAL annunciator light and then saw that the right hydraulic system pressure was about 1,000 pounds per square inch (PSI).

Approximately 1736, the FO stated, "we've lost pressure on the right side" and ten seconds later commented "...we lost the quantity, too." Approximately three minutes later the FO called for the 'climb check'.

The CAPT stated that he noticed the right hydraulic system quantity decreasing rapidly. The CAPT reached over to turn off the hydraulic pumps but later noticed that he had only selected the right engine hydraulic pump switch to the LOW position instead of OFF. He then corrected the switch position to OFF and finished the COM Hydraulic Pressure Low and/or Fluid Loss procedure.

Approximately 1745, the FO asked "what's its say, or your thoughts about continuing?" and the CAPT responded "well we're gonna talk to everybody before we make any decisions. I don't see an urgent need to be turning around right this second," and the FO responded "I don't either." During the next ten minutes the CAPT and FO discussed the need for manual gear extension and the loss of the outboard spoiler system. During this discussion, it was noted that the right side hydraulic quantity had risen to indicate four quarts.

The CAPT stated that there was no emergency, and the FO continued flying the airplane. Above 10,000 feet, the CAPT transferred both the flying and ATC communication duties to the

FO while the CAPT referred to the NWA DC-9 Cockpit Operating Manual (COM) to complete the procedures. He stated that he referred to the procedure in the COM for right hydraulic system quantity loss and went through the procedure several times. During this time, the right engine hydraulic pump switch was repositioned from LOW to OFF. He then read ahead through the emergency gear extension procedure.

The CAPT stated they had a situation that would involve a manual rudder, which means that they had to have an adequate amount of runway and would have to fly a little faster speed on the approach. He and the FO discussed the procedure, and they tried to reset some circuit breakers to regain hydraulic pressure from the auxiliary hydraulic pump. The CAPT wanted to get the FO more involved; therefore, he asked him to read through the procedures.

Approximately 1756, the CAPT began communications with maintenance control (MAINT) to discuss the hydraulic problem. The right hydraulic system fluid quantity was indicating five quarts and while they were talking, it had increased to six quarts. He asked the MAINT mechanic what he thought the problem was, and the MAINT mechanic said that he had never seen anything like that, but it sounded like there was a problem with the hydraulic fluid reservoir. The CAPT interpreted that to mean that the mechanic thought there was a problem with the fluid quantity transmitter on the reservoir. The CAPT ended this communication approximately three minutes later, stating "roger that we will continue back to Minneapolis then" and confirmed that dispatch had copied the entire exchange. He decided to continue on to MSP in order to burn off some fuel to reduce the weight of the airplane. He also discussed the situation with the FO before deciding to continue to MSP. He decided not to immediately declare an emergency with ATC because he thought the situation was stabilized.

The CAPT stated that he once again went through the procedures in the COM. The right hydraulic system pressure was indicating zero, but the hydraulic low pressure light (R HYD PRESS LOW) on the annunciator panel was not illuminated. He said that he performed an annunciator panel light test and found the light bulbs for the right hydraulic system pressure low light were inoperative. He had checked the annunciator lights on preflight and they had all been working normally. When he attempted to change the bulbs, the entire housing came apart. He stated that he basically slammed the door closed and the light came on, but it was so broken up that he was not certain if the light came on because the housing was broken or if the light came on because it was actually indicating low pressure.

The CAPT stated that the checklist was straightforward but when he ran the COM checklist, there was confusion when trying to decide what problem they really had and whether they were using the correct checklist. It was really confusing when the right system hydraulic quantity came back up, and there was no hydraulic pressure low annunciator light. He said he told the FO that they had to look at what they had and go by the proper checklist.

Approximately 1815, the CAPT stated, "alright now I can read the procedure. Start to finish. Hydraulic pressure low [unintelligible]."

The CAPT stated, "We finally decided to address what was indicated, which was low hydraulic pressure on the right side and normal quantity of hydraulic fluid on the right side." On the left side, both pressure and quantity were normal. Both he and the FO went through the procedure for right hydraulic system quantity normal but pressure low. Following the procedure, the brake selector was selected to the left side, and the rudder control was placed in manual. Later there were Airborne Communications and Response System (ACARS) communications with

Dispatch. Dispatch suggested using runway 22 for landing at MSP in case they had to stop on the runway and have the landing gear "pinned" and the landing gear doors raised. The CAPT told them that he wanted a truck standing by to "pin" the landing gear when they arrived. He did not declare an emergency immediately because they were not sure if they were going to have to use the emergency landing gear extension. The FO stated that he thought they should go ahead and declare an emergency because of the manual rudder. The CAPT stated that that was a valid point, and he then declared an emergency with ATC.

The CAPT stated that when they were about half way into the flight, the hydraulic quantity indication continued to rise to a normal level, about eight quarts. He and the FO discussed the situation and decided that there was normal hydraulic quantity but low hydraulic pressure on the right hydraulic system, and normal hydraulic pressure and quantity on the left hydraulic system. They went through the procedures again.

They had lots of time to discuss the runway, when to start the descent, and how they would extend the landing gear. They were not sure if the landing gear would come down normally or if they would have to use the alternate landing gear extension method. The CAPT stated that they had plenty of fuel and decided to lower the landing gear early.

Approximately 1835 the CAPT briefed the lead flight attendant (Position A FA) on the situation and intention to declare a "yellow emergency". (Yellow emergency is a NWA specific terminology).

He stated that after they decided on a course of action, he then briefed the flight attendants (FAs). The first FA to come to the cockpit was the "add" [additional] FA, so he decided to brief her and later briefed Position A FA. He told her about the entire situation and that there were two possible scenarios regarding the landing gear: one, if the gear came down normally and two, if they had to use the alternate method of landing gear extension. If they had to use the alternate method of lowering the landing gear, he wanted the FAs to prepare for a "yellow" emergency. He told them that if this were the case, they would be stopping on the runway and not to be alarmed if rescue and fire trucks were seen near the airplane. If it was not going be a normal landing, he told the FAs he would give them about ten minutes notice before landing.

Approximately 1850, the CAPT contacted dispatch to request that they "call out the trucks" for their arrival. Approximately 30 seconds later the FO began briefing the approach to runway 22.

The FO stated that he tuned in the Automatic Terminal Information Service and heard weather of 5,000 feet broken with 10 miles visibility. He briefed for a visual approach to runway 22 with a localizer backup. There was no instrument landing system (ILS) on runway 22.

Approximately 1900, the FO noted 'we just lost our quantity.' Approximately one minute later the CAPT radioed to MSP center "ah we got a hydraulic problem, we're gonna go ahead and declare an emergency. ah everything should be okay but just gonna have to land a little faster and we're gonna have the trucks standing and everything."

The CAPT stated that MSP Approach Control started giving the flight radar vectors and he had to remind them that they were an aircraft in an emergency situation. Approximately 1905, they were on approach and the CAPT and FO both indicated that the landing gear had extended successfully. They did not use the Emergency Gear Extension Handle. When MAINT said there may be a reservoir problem, he thought there was a higher chance that it was an indication problem and then when the landing gear came down, it reinforced this idea. He

thought to himself that he must not have had a problem with that hydraulic system.

At 1908, the Minneapolis Saint-Paul Metropolitan Airport Commission (MAC) Fire Department received an initial notification call from ATC for an alert 2 (according to the MSP Emergency Plan, an Alert 2 notification prompts ARFF to "stand-by at predetermined locations at a runway for incoming aircraft with a problem").

The FO stated that he flew a long slow downwind from Farmington to a downwind leg to runway 22. He turned onto the localizer course at an altitude about 3,000 feet. The flight was then cleared for the approach to runway 22. He observed a cloud ahead, which prevented him from seeing the runway. He stated that he told the CAPT that he could not descend at that point without seeing the runway; therefore, he requested that the CAPT tune in the crossing radial to identify a fix along the localizer course. The FO stated that he saw the runway visually by the final approach fix.

Approximately 1919, the FO called "flaps 40 landing check."

1920:44, TWR, Northwest fourteen ninety five Minneapolis tower runway two two cleared to land winds calm you're number two for the airport traffic three mile final runway three zero left.

1920:54, RDO-1, cleared to land ah two two Northwest fourteen ninety five you're aware we cle - declared emergency and we won't be able to go around.

1920:60, TWR, roger. And Northwest fifteen ah thirty six traffic emergency landing runway two two I'll need you I know you can't commit it's a wet runway but ah just don't delay ah around two two either roll through it or stop short of it.

1921:08, CAPT, down and green flaps forty. forty blue. spoilers armed. checklist complete.

The CAPT stated that there was a visual approach slope indicator (VASI) on runway 22. As they approached the runway they drifted a little high on the VASI but then corrected and accomplished an uneventful landing in the proper touch down zone. The FO stated that upon landing, he applied brakes a little earlier than normal to make sure they were working. Reverse thrust was also working.

1923:01, CAM, [sound similar to tires contacting runway and auto-ground spoilers activating].

1923:02, FO, still **. ah ya.

1923:04, CAPT, (go back).

1923:09, CAPT, reverse normal.

1923:29. FO, you got the plane.

1923:30, TWR, ...ah you want the equipment out there?

1923:30, CAPT, I got it.

1923:31, RDO-1, ah fourteen ninety five we're okay ah, everything's good to go.

1923:34, TWR, roger stow the equipment?

1923:37, RDO-1, yes sir.

1923:37, TWR, roger.

1923:41, FO, you got the plane. yea...

1924:04, RDO-2, ground Northwest fourteen ninety five's ah clear of two two and ah no longer need any assistance for the ah emergency response.

1925:35, CAPT, flaps came up and everything *.

1925:37, FO, ...complete. yea they did.

The CAPT stated that after landing, the hydraulic low-pressure annunciator light stayed on while rolling down the runway. He thought that the light was broken. He was thinking that everything was normal. After landing, the CAPT felt relieved. As they were slowing down on the runway, he told TWR that the emergency vehicles were no longer needed. After clearing the runway, the CAPT called for the flaps to be retracted and then called for the After Landing checklist. The FO completed the After Landing checklist while the CAPT retracted the spoilers and turned off the landing lights and antiskid.

The flight exited the runway on taxiway C2 and were then cleared to taxi on taxiway C, make a left turn on taxiway C3, back-taxi on runway 22, and hold short of runway 30L. The CAPT had to taxi the airplane from the taxiway back onto the runway because of construction activity. Runway 22 was then used as a taxiway. The CAPT stated that he had forgotten and was surprised that there was construction along the runway. While taxiing, the CAPT stated that he looked at the brake accumulator gauges for pressure just before crossing runway 30L and they were both normal.

At 1928:05, South Ground Control cleared NWA 1495 to "cross runway three zero left turn right on alpha taxi to the gate traffic on Charlie is waiting for you." NWA 1495 acknowledged the clearance.

The FO stated that he accomplished the after landing "flow," did the After Landing checklist, and called Ramp Control to confirm gate G7.

At 1928:36, CAM recorded [sound of mechanical click followed by high frequency noise reducing in frequency, sound of clunk, and high frequency noise stabilizing - sound similar to engine shutdown]. According to the Flight Data Recorder Specialist's Factual Report, at 1928:42, the left engine pressure ratio (EPR) decreased to 1.01 and remained at the value until the end of the recording, which was 1936:42.

The CAPT stated that it was his typical routine to not shut down an engine until clear of all runways. He stated that he did not recall shutting down the left engine, but he stated that if he had shut down the left-hand engine, he would have done so after crossing runway 30L. After crossing runway 30L, he made a right turn onto taxiway A. They were taxiing by the "tunnel" when they started to have problems. They made a slight gradual turn into the gate area. He had just started to turn into the gate from taxiway A when the nose wheel steering failed.

1930:09, FO, * terminator. Can't steer? [sound of laughter].

1930:15, CAPT, #. There went my steering. Can't # steer it. There goes the left system pressure.

1930:23, FO, huh?

1930:24, CAPT, we just lost our left system pressure.

1930:25, FO, well. You - are you ah.

1930:31, CAPT, our left system pressure.

1930:31, FO, yea I know I see that went down into low.

1930:36, CAPT, son of a #.

1930:39, FO, all right let me a - you ah.

1930:45, CAPT, I don't know if I can get in there or not.

1930:46, FO, yea you might be able to steer it kinda slightly there maybe they can tow us in. [sound of laughter].

1930:57, CAPT, lean would ya?

1930:59, FO, [sound of laughter]. Ahhh lets *.

1931:05, CAPT, ah I gotta do this just right. I ain't gonna have much. Look at that there's nothin'.

1931:11, CAPT, no pressure at all.

1931:15, CAPT, uh oh. #.

1931:17, FO, * you got brakes?

1931:18, CAPT, no.

1931:21, CAM, [sound similar to thrust reverser throttle up].

1931:22, FO, there ya go use it.

1931:26, FO, here I'll get it I'll get it let me get it. Let me get ground out of the way here. Why are we a - use ah the brake lets see you got the brake.

1931:37, CAPT, (#).

1931:39, FO, all right.

1931:39, CAPT, lost the frikkin' brakes.

1931:40, FO, * what what do you.

1931:41, CAPT, dropped off.

1931:42, FO, you got a -

1931:42, CAM, [banging sound similar to multiple brake pedal applications]

1931:42, FO, what's the pressure over there? Dropped off er - yea you - what about the brake handle.

1931:50, CAM, [sound of click].

1931:51, CAM, [sound of multiple brake pedal applications].

1931:51, FO, try it. Now look it's bleedin' off.

1931:55, CAPT, yup.

1931:58, FO, yea 'cause see we lost. We lost everything on our...

1932:01, CAPT, son of a # * that was.

1932:02, FO, ...we lost * we lost everything on our...

1932:03, CAPT, ****.

1932:03, FO, yea I I'll tell I'll I'll tell em here.

1932:06, CAPT, we're dead in the water.

1932:07, FO, yea I'll tell 'em that.

1932:16, FO, ahhh you want a call.

1932:18, CAPT, *.

1932:18, RDO-2, ground Northwest fourteen ninety five.

1932:21, GND, Northwest fourteen ninety five ground.

The FO stated that he thought the CAPT was kidding about losing the steering but when he realized the CAPT was not kidding, he advised Ground Control that they were experiencing steering problems and would probably have to be towed to the gate. He then called MAINT and told them the same thing. Then the CAPT said that he was losing the brakes. The FO stated that he saw the CAPT's hands "come up" and apply reverse thrust. The airplane came to a stop.

The CAPT stated that after the brakes failed, he said that he immediately brought in the thrust reversers and the airplane stopped. He asked the FO to try the brakes. The brake pedals went right down to the floor. The CAPT said that when he looked at the left hydraulic accumulator, it was down to zero and the right side accumulator was near normal. Part of the COM procedure was to turn the brake selector to the left side, which he had done. He then moved the brake selector to the right and watched the right brake accumulator go immediately to zero. He stated that now they were "dead in the water."

1932:23, RDO, well our bad day got worse ah we lost ah all our control over the brakes and steering with our hydraulic problem so we stopped right here. and uh -

1932:33, RDO-2, we can't move at all and we * appreciate keeping any airplanes away from us 'cause we can't uh...

1932:39, RDO-2, "...have no brakes. Were havin' to use thrust reversers to keep from rollin'.

1932:44, GND, Northwest fourteen nine ninety five ha roger ah you * gonna shut down there you gonna get (a tug out then)?

1932:49, RDO-2, ah we're gonna shut down here...

1932:50, CAPT, no can't shut down.

1932:52, RDO-2, ...we uh ** I mean not shut down we're gonna have 'em come uhm...

1932:53, CAPT, gotta use the reversers

1932:55, RDO-2, ah chock it or put a tu- tug up before we shut it down otherwise we won't have any ability to keep the airplane ah from rolling just on the tarmac here.

1933:04, GND, Northwest fourteen ninety five roger a have you called company already have them a tug on the way?

1933:09, RDO-2, ah we're gonna do that just now we just wanna let you know first wha- why

we're sittin' here.

1933:13, GND, thank you.

1933:15, FO, ah I'm gonna call maintenance.

1933:19, RDO-2, maintenance Northwest fourteen ninety five.

1933:22, MAINT, calling maintenance?

1933:24, CAM, [sound similar to flight attendant call chime].

1933:24, RDO-2, yea hi fourteen ninety five ship number nine eight five four we're the ah we're the aircraft that's had the emergency land with hydraulic failure and ah we lost the rest of our ah system here taxiing in and we cannot - we don't have any brakes and a no steering. We're stopped just abeam Golf seven if you could ah bring a crew out here with a tug and some chocks whatever's needed and ah bring us in the rest of the way.

1933:26, INT-?, ah we have (a little) problem ah it's not an emergency buy (let's ah) **. (stop) we can (just).

1933:49, MAINT, okay copy that.

1933:51, CAPT, Jeeze can't believe it.

1933:54, FO, they're gonna bring a tug an ah. (and I ah). Yea because we gotta have the ability if the thing starts to roll we can't do anything we gotta be (to have the ability to).

1934:07, CAPT, yea I didn't' want shut the engine down.

1934:08, FO, oh yea yea we got way to st - you're right then all of a sudden then we're just a roller...

1934:12, CAPT, try the brakes. its s-scary.

1934:14, CAM, [sound similar to brake pedal application]

1934:16, FO, ** # I watched it all just bleed off when it -

1934:23, CAPT, I though we were -

1934:24, RDO-2, and uh maintenance Northwest fourteen ninety five.

1934:29, MAINT, calling maintenance?

1934:29, CAPT, (son of a #).

1934:32, RDO-2, yea ah fourteen ninety five how do you read?

1934:34, MAINT, loud and clear.

1934:35, RDO-2, I just want to reiterate that we have no no brakes at all no ability to stop fortunately we're stationary on the on the ramp here abeam Golf seven but we're but we're keeping the engines running in case we have to use reverse but we cannot control the airplane right now so I don't know if you want to advise maintenance on how to approach us here you know...

1934:52, CAPT, chock us.

1934:52, RDO-2, ...the appropriate way chock us first and then hook us up whatever probably

chock us first to keep us from rolling into something.

1934:57, MAINT, okay ah we'll let 'em know that.

1935:00, RDO-2, yea it's kinda of a precarious situation here is what I'm getting' at.

1935:03, MAINT, yea it's gonna be a couple of minutes ah*.

1935:06, GND, * fourteen ninety five * (hold of) company any idea how long for the tug?

1935:09, MAINT, it's gonna be a few minutes ah we need an escort out there ah he's on his way so ah just hang tight.

1935:10, RDO-1, ah we're talking to him right now ah hopefully it won't be too long.

The FO stated that he called MAINT again and told them that they had lost steering and brakes and that they needed to have the airplane chocked. MAINT asked if they would shut down the engines and the CAPT said, no, he needed them for the reversers. The FO stressed that they needed to get somebody out there right away; they were in a very precarious situation. MAINT said they would have somebody out as soon as they could.

1935:17, FO, you want me to...

1935:18, CAPT, you know what? I coulda lost my # reversers. We coulda gone # right into that airplane.

1935:25, FO, I know. soon as you started goin' reverse then I said #. This ah.

1935:32, CAPT, why the # what did I do wrong?

1935:33, FO, well nothin' I'm just trying...

1935:34, CAPT, why the # did we lose that pressure?

1935:35, FO, well wha I'm try - I don't know. we've lost ah.

1935:39, CAPT, lost everything. Son of a #.

1935:43, FO, I don't ah I don't unders- okay. I don't I don't what the deal is why do we -

1935:50, CAPT, got quantity on the left side, no pressure. We (coulda) go like this.

The FO stated that he made a PA announcement to the passengers telling them that the airplane was experiencing a system malfunction; they were going to stay put and then be towed to the gate.

The CAPT stated that the FO suggested shutting down the engine, but the CAPT wanted to keep it running for the thrust reverser. He added that it was just then that they began to slowly roll forward.

1936:13, CAPT, lost my #, reversers.

1936:17, FO, now you lost your reversers.

1936:18, CAPT, yea.

1936:18, FO, #.

1936:23, RDO-2, ground ah -

1936:25, FO, you can't steer or anything?

1936:26, CAPT, no.

1936:26, FO, #. #.

1936:31, GND, fourteen ninety five got your problem worked out?

1936:31, CAPT, oh #.

1936:32, FO, come on.

1936:34, CAPT, ohhh #.

1936:36, FO, okay.

1936:39, CAPT, 3. ugh.

He said that the ramp looked flat but there may have been a slight slope in the ramp. He did not know if it was the ramp slope or engine thrust that made the airplane start to creep forward. He tried using the engine reverse thrust to stop the airplane, but the thrust reversers did not deploy. He did not think of it then but now he knows the engine thrust pushed them forward. He said that he pulled the reverser back again but from then on there was nothing they could do.

The FO stated that when the airplane started moving toward the gate, he saw the CAPT's hand pulling up on the reverse levers. The airplane started to roll; the reversers did not stop it. The CAPT may have done one more cycle of the reverse levers but he was not sure. The FO stated that it never dawned on him that the left engine was shut down. There had been no comment from the CAPT about shutting down an engine.

The CAPT stated that when the DC-9 started moving towards the A-319, he saw its wing coming towards him, and ducked to his right.

1936:40, CAM, [sound similar to impact].

The FO stated that as they approached the A-319, he saw the A-319 wing coming at him. He "dove" to his left and hit his ribs on the center console. The cockpit imploded and glass came flying in. He was stunned. He took a "wallop to the head" and his ribs were sore. He could not see the CAPT because a panel was in the way. The FO then reached down to shut off the engines. He stated that he turned off the right fuel control lever and when he reached for the left fuel control lever, he realized that it was already turned off. At least it felt that way; he could not see it. The CAPT was moaning. Fuel started coming into the cockpit. The FO tried to open the sliding clearview window to his right, but it would only open part of the way. He then observed a tug pull up to the airplane and screamed to the tug driver to call for the fire trucks.

The CAPT said that the DC-9 hit the aft part of the A-319 right wing after sliding under its horizontal stabilizer. The CAPT stated that it was a lot more of a collision than he had expected. He did not remember the exact sequence of events but soon after the collision, the CAPT felt fuel pouring in on him and he was pinned in his seat, both arms pinned also, and he could not move. He thought to himself that he was going to burn right there in the seat. The CAPT said he could hear the FO yelling to shut down the engines. The CAPT managed to free his right arm, which he used to shut down an engine; he did not know which one. He said that the other fuel control lever was already in the OFF position.

He could not reach his seat belt but he was able to reach the seat recliner lever and was able to

slide the seat back a few inches. He stated that he was then able to release his seat belt. The CAPT stated that there was a lot of wreckage in the cockpit between the two pilot seats. He said he could only see the FO through a small opening in the middle and that it appeared that he was okay. The FO had his clearview window open talking to someone outside. The CAPT thought that the FO was going to go out that window. The CAPT said that he tried to open the cockpit door, but that it was too hard to open. He tried to get the door open by kicking it, but he still could not get the door open. He said he could hear someone yell, "Are you okay?" He yelled back that he was not okay. He continued to open the cockpit door and escape, but it was not until some guys helped pull the door open from the other side that he was able to get out. He did not know how he got out of the cockpit but he remembered thinking, "I don't want to burn."

The CAPT said that he proceeded to the rear of the DC-9 and exited via the aft door stairs. He said that he believed that there was no one left on the airplane. He said he would never have left the airplane if he had thought that the FO was still on board. He honestly thought the FO was going out through the right cockpit window.

The FO stated that he assumed the FAs initiated the passenger evacuation. Right after the collision, no calls were made and the CAPT was not responding. The CAPT was able to dislodge himself and get out of the cockpit and exit the airplane through the aft cabin door. The FO asked the ground crew to open his clearview window but the window would not open. One of the ground crew personnel told him to get the fire ax, which he did. The ground crew person starting banging on the window with the fire ax, but with little success. "Three, four, five minutes" went by and then fire and rescue personnel arrived. The rescue personnel asked him if he could move to his left or right; he said, no, but then he squirmed out of the right side of his seat and got out of the cockpit. He saw no one on the airplane. He walked through the cabin and exited out the rear of the airplane. He saw that the CAPT was already out of the airplane. The FO noticed that the CAPT had fuel all over him and that the CAPT was having some trouble standing and breathing. They both got into an ambulance and were taken to a hospital.

The Airbus A-319 CAPT stated that it started out as a normal routine flight, pushing back from gate G10 at MSP. No turns were made on the pushback and the tail of the airplane was pointing towards the southwest. The parking brake was set and they had received the wave-off from the tug driver and the tug was moving toward the terminal. He had called for the Before Taxi checklist.

He tuned in the Ground Control frequency and was about to make the call for taxi. Both engines were running and they were just getting ready to taxi to runway 30L. The CAPT stated that there was a tremendous jolt to the airplane and it began moving forward and to the left. He "stood" on the brakes, but he could not stop the airplane from moving. There were no warnings. He estimated that the airplane was pushed about 20 or 30 feet. They did not hear anything on the radios from ground control or the company.

About five to six seconds later, the airplane came to a stop. He was not sure what was going on as there were no Electronic Centralized Aircraft Monitor (ECAM) messages. At first he thought there was a hydraulic system failure. There were no warnings or bells. He could see ground personnel coming toward the airplane.

Either the FO or a FA opened the cockpit door and said an airplane or fuel truck had hit the airplane. Someone on the ground was giving him the "cut engine" signal. The engines were shut down and the Parking checklist and Securing checklist (except for the emergency lights) were accomplished.

The Airbus A-319 FO stated that during the impact, it felt like the brakes were grabbing and releasing. He thought that there may have been a brake problem or maybe they got hit by a tug. It was not one big bang; instead, it was a series of three skips forward. He did not detect a sideways movement but the CAPT told him afterwards that the airplane was trying to turn. He thought that the airplane moved about seven or eight feet forward. He stated that the CAPT thought that the airplane moved farther.

There was no electrical power on the airplane because the auxiliary power unit (APU) had already been shut down. He tried to get a signal from the ground crew to start the APU, but did not get it. He then noticed activity on the right side of the airplane. He looked out the window and saw the DC-9 under the wing. He could see the front of the DC-9 and he could see an aileron bent upward. The DC-9 cockpit windows were broken. The CAPT made a PA announcement to the passengers. The FO opened his window and could hear ramp personnel say the stairs were on the way. The CAPT then opened his window, opened the cockpit door, and talked with the FA in the A position. He asked her if she was okay. She had a minor mark on her hand resembling a carpet burn. He could hear ground personnel saying fuel was leaking and could see it through his window, but he did not smell any fuel while inside the airplane. Someone on the ground said, "blow the chute." He did not see the person who said that but he thought it came from a person on the ground on the CAPT's side of the airplane. There was no delay in "blowing the chute," and the process went very quickly.

The CAPT stated that he looked out the window and saw the other airplane. He told the FA that they would be deplaning. The cockpit windows were open. A mechanic said that there was fuel leaking so he told the flight attendant to prepare for evacuation. The passengers were calm and waiting for the crew to tell them what to do. There was no panic, crying or screaming. He decided not to wait for the stairs to begin the evacuation. Once he gave the order to evacuate, a FA opened the left forward door and deployed the slide. The evacuation was accomplished within three minutes. The passengers wanted to take their carry-on bags down the slide but the flight attendants stopped them from doing that. He then went to the rear of the cabin to make sure there were no remaining passengers on board the airplane.

The CAPT stated that all passengers were off the airplane in less than 10 minutes after the impact. There were three FA's on board, one of which was injured and subsequently taken to the hospital. The other two FA's did not report any injuries. Further, he was not aware of any passenger injuries. Everyone exited through the left forward cabin door. The FO went down the slide, followed by the CAPT, who was the last person to evacuate from the airplane. The FO estimated that it took about six minutes from the time of impact until the evacuation was completed. The FO stated that the ground personnel helped with the evacuation by manning the sides of the evacuation slide as people were evacuating. The fire chief approached them and asked if everyone was off the airplane. The CAPT said, yes.

The CAPT stated that he got the crew together and met a supervisor that brought everyone up the stairs into the terminal building.

METEOROLOGICAL INFORMATION

MSP automated weather observing system recorded the following observations:

At 1853, the wind was from 230 degrees at 10 knots, surface visibility 10 statute miles (sm), weather light rain, sky conditions 3,900 feet above ground level (agl) broken, 5,000 feet agl broken, 11,000 feet agl overcast; temperature 16 degrees Celsius (C), dew point 13 degrees C, altimeter 29.91 inches of mercury (Hg).

At 1953, the wind was from 240 degrees at 4 knots, surface visibility 10 sm, sky conditions few clouds at 1,100 feet agl, scattered 3,700 feet agl, broken 11,000 feet agl, overcast 14,000 feet agl; temperature 15 degrees Celsius (C), dew point 13 degrees C, altimeter 29.93 inches of mercury (Hg).

The Airbus A-319 FO stated that the ramp conditions were good at the time of the accident. The temperature was about 60 degrees with light winds. Ambient lighting was not a factor. He could see clearly all around.

AIRPORT INFORMATION

MSP is located in St. Paul, Hennepin County, Minnesota. The airport is located approximately six miles southeast of downtown Minneapolis with coordinates of 44 degrees 52 minutes 59.9 seconds North and 93 degrees 13 minutes 0.9 seconds west and an elevation of 841 feet mean sea level.

The airport is served by runways 4-22 (10,006 feet by 150 feet, grooved concrete), runway 12L-30R (8,200 feet by 150 feet, grooved concrete), and runway 12R-30L (10,000 feet by 200 feet, grooved concrete). The airport has 24-hour air traffic control tower service.

The MSP Commission (MAC) wrote the MSP Airport Emergency Plan (AEP), which was approved by the FAA on February 24, 1989, and revised on January 1, 2004. According to the AEP, MSP, airport tenants, and mutual aid agencies have many resources that can be used to prepare for, respond to, and recover from a major disaster at MSP. Available resources include facilities, equipment, personnel, plans and procedures.

The AEP stated that MSP FAA ATCT is responsible for notifying the MAC Communications Center of aircraft emergencies. This is done via direct phone line to the Communications Center and a direct link to the public address systems in the MAC Fire Station and the MAC Airside Operations Center. Once on site, the MAC will implement Incident Command (IC), or Unified Incident Command, for emergency incident response and recovery at MSP. IC is used to provide a centralized command and control of resources and communications during incident response and recovery.

FLIGHT RECORDERS

The DC-9 was equipped with an Allied Signal 6022 SSCVR 120, serial number 04155, cockpit voice recorder (CVR) with a Dukane underwater locator beacon. The CVR exterior showed no signs of impact or fire damage. The underwater locator beacon tested good. Information from the CVR consisted of six tracks of fair to good quality audio recordings. Two tracks were approximately 2 hours long and the remaining four were approximately 30 minutes long. The two-hour recordings consisted of one track containing the sum of both the CAPT and the FO's audio panel information, and one track containing information from the CAM. The 30-minute recordings consisted of audio information from four independent sources. The first track contained no usable cockpit audio; the second track contained the CAPT's audio panel information; the third track contained the FO's audio panel information; the fourth track

contained audio information from the CAM. The event was captured near the end of the recording.

A time correlation between the CVR recording and data from the flight data recorder (FDR) was performed. This was accomplished by performing a mathematical cross-correlation between two independent data sets. The first data set was obtained from the recorded microphone on-key/off-key information. The second data set was obtained from the CVR recording by noting a representative sample of radio transmission start/stop times. Conversion from elapsed time to local time was established using data from a Federal Aviation Administration (FAA) transcript of ATC transmissions to the aircraft.

The DC-9 was equipped with a L-3 Communications Fairchild Model F1000, 64 Word FDR, serial number 01133. The FDR records airplane flight information in a digital format using solid-state flash memory as the recording medium and can record a minimum of 25 hours of flight data. It is configured to record 64 12-bit words of digital information every second. Each grouping of 64 words (each second) is called a subframe.

The FDR recording contained approximately 103 hours of data. Timing of the FDR data is to the nearest second and referred to as FDR subframe reference number (SRN). The accident flight was the last flight of the recording and its duration was approximately 2 hours and 2 minutes. Although there was no loss of sync in the data, invalid data were recorded a few seconds prior to the end of the recording. The invalid data are most likely a result of airplane damage sustained during the accident sequence.

Correlation of the FDR data from SRN to the accident local time was established with an offset provided by the CVR Group Chairman in the Factual Report of Investigation Cockpit Voice Recorder. The accident flight data has been offset from SRN to local CDT using the following relationship: 372249.2 SRN =19:20:54.0 CDT. Previous landings are shown to the nearest second in relative FDR time (SRN).

PERSONNEL INFORMATION

DC-9 Captain

The DC-9 CAPT had been employed as a pilot by NWA since 1985. He was issued an airline transport pilot (ATP) certificate in 1995. The ATP certificate included an airplane multiengine land rating and EMB-110, CV-A340, CV-A440, DC-9 type ratings. The DC-9 type rating was issued in 1995. He also held commercial pilot privileges in airplane single-engine land airplanes.

He accumulated a total flight time of 20,000 hours, of which were 6,709 hours as pilot-in-command in DC-9 airplanes. He accumulated 116 hours in the previous 90 days, 71 hours in the previous 30 days, and 13 hours in the previous 7 days leading up to accident.

He received his last DC-9 recurrent ground training on April 3, 2005, and DC-9 line oriented evaluation (Proficiency Check) on April 6, 2005. His last line check was July 1, 2003.

There were no FAA records of enforcement actions, accidents, incidents or violations. There were no records of company disciplinary actions. A search of the National Driver Register yielded no history of driver's license revocation or suspension.

He was issued a first class medical certificate on May 2, 2005, with the following limitation: must wear corrective lenses.

DC-9 First Officer

The DC-9 FO was employed as a pilot by NWA since 1997. He was issued an ATP in 1992 with an airplane multiengine land rating. He also held commercial pilot privileges on B-707 and B-720 airplanes and private privileges on airplane single engine land airplanes.

He accumulated a total flight time of 7,000 hours, of which were 3,985 hours as second-in-command in DC-9 airplanes. He accumulated 174 hours in the previous 90 days, 76 hours in the previous 30 days, and 12.8 hours in the previous 7 days leading up to accident.

He received his last DC-9 recurrent ground training on November 17, 2004, and DC-9 line oriented evaluation (Proficiency Check) on November 20, 2004. His last line check was July 22, 2004.

There were no FAA records of enforcement actions, accidents, incidents or violations. There were no records of company disciplinary actions. A search of the National Driver Register yielded no history of driver's license revocation or suspension.

He was issued a first class medical certificate on October 21, 2004, with no limitations.

A-319 Captain

The CAPT was employed as a pilot by NWA since 1978. He held an ATP with A-320, CV-340, CV440, and DC-9 type ratings.

He accumulated a total flight time of 16,288 hours, of which 4,750 hours were in the A-319 airplanes. He accumulated 203 hours in the previous 90 days, 66 hours in the previous 30 days, and 5 hours in the previous 7 days leading up to accident.

He received his last A-319 recurrent ground training and line oriented evaluation (Proficiency Check) on November 7, 2004.

He was issued a first class medical certificate on May 6, 2005, with the following limitation: corrective lenses required.

A-319 First Officer

The FO was employed as a pilot by NWA since 1996. He was issued an ATP with BE-1900, BE-300, DHC-8, and SD-3 type ratings.

He accumulated a total flight time of 6,344 hours, of which 1,070 hours were in the A-319/320 airplanes. He accumulated 224 hours in the previous 90 days, 84 hours in the previous 30 days, and 7 hours in the previous 7 days leading up to accident.

He received his last A-319/320 recurrent ground training and line oriented evaluation (Proficiency Check) on January 9, 2005.

He was issued a first class medical certificate on November 18, 2005.

AIRCRAFT INFORMATION

DC-9 Airplane Information

The 1976 McDonnell Douglas DC-9-51, serial number 47716, was registered to NWA on December 29, 1986. The airplane accumulated a total time of 67,268 hours and 66,998 cycles. The airplane was last inspected during an L-check that was completed on August 6, 2004. The L-check would not have provided for the inspection of the rudder shutoff valve. The last

maintenance check that provided for this inspection was an M-check, which was completed on December 14, 2002. The M-check provides for an operational check of the rudder hydraulic shutoff system and manual reversion mode. The M-check also provides for a zonal general inspection "that would have looked at the component itself."

The airplane cabin was configured with a dual-class, single-aisle configuration with 109

coach class passenger seats, and 16 first class seats.

The airplane was powered by two Pratt and Whitney JT8D-17 engines with a rated maximum continuous thrust of 15,200 lbs at standard day conditions.

A-319 Airplane Information

The 2003 Airbus A319-114, serial number 2039, was registered to NWA on October 9, 2003.

The A-319 cabin was configured as a dual-class, single-aisle configuration with 108 coach class passenger seats and 16 first class seats. No damage was observed in the cabin. There were 4 floor-level door exits and 2 overwing window exits.

WRECKAGE AND IMPACT INFORMATION

A forensic map created by the Minnesota State Patrol depicts both aircraft with 40-60 foot long skid marks from the A-319. The forensic map is included in the docket of this report.

Grade information for gate G13 shows a 0.84 percent downward slope towards the gate from a point perpendicular to the G Concourse 600 feet to 200 feet away. The downward grade along the southerly direction and parallel to gate is depicted as 0.53 percent.

Wear consistent with damage normally incurred to the skid plates during an emergency gear extension was noted to be absent on the DC-9 main inboard landing gear door skid plates.

Documentation of the cockpit revealed the following switch positions relating to the hydraulic system:

ENG L - HI

ENG R - HI

AUX - ON

ALT - ON

The left hydraulic quantity indication was 14 quarts and the right hydraulic quantity indication was 0 quarts.

The left wheel well accumulator pressure indications were:

System: 1,000 psi

Inboard Brake: 600 psi

Outboard Brake: 650 psi

Reservoir Fluid Quantity: Above FULL

Filter Delta Pressure Indicator - Not extended

Fire Hydraulic Shutoff Valve - Open

The thrust reverser accumulator pressure indications were;

Left - 800 psi

Right - 700 psi

MEDICAL AND PATHOLOGICAL INFORMATION

Results of blood tests of the DC-9 CAPT and FO were reported to have negative findings for the CAPT and 0.03 milligrams per liter of morphine for the FO. The FO was administered morphine in the Emergency Room the night of the accident.

FIRE

There were no reports or evidence of smoke or fire on board the DC-9 or the A-319.

SURVIVAL ASPECTS

The Survival Factors Group documented injuries sustained in the accident, the airplane evacuation timelines, both airplane cabins, the airport certification and response, and the

airport emergency plan. The Group also interviewed the flight attendants from the DC-9 and A-319, emergency response personnel, and company ground personnel. The Group Chairman sent out passenger questionnaires to all 94 passengers aboard the DC-9 and all 39 passengers aboard the A-319. Only 20 questionnaires from the DC-9 passengers and 27 questionnaires from the A-319 passengers were returned to the Group Chairman.

TESTS AND RESEARCH

Video Study

A video study by the National Transportation Safety Board's (NTSB's) Vehicle Recorder Division was performed on video that captured the collision of the DC-9 and A-319. The study documented a collision speed using two methods. The first method derives an approximate speed of 16.53 miles per hour (MPH). The second method provides speeds of 15.65 MPH and 16.34 MPH. The maximum range of lowest and highest estimates within the standard errors of these measures is 15.38-16.61 MPH.

DC-9 Flight Data Recorder Plots

FDR plots included in the docket of this report show that touchdown of the DC-9 occurred at 1922:59. At 1928:42, the right engine pressure ratio (EPR) decreased to 1.01 and remained at the value until the end of the recording. At 1936:06 the right engine EPR began to increase, reaching 1.19 at 1936:25 and remaining approximately that value until the end of the recording. Also, at that time, the airplane's heading began to turn to the left from 106.2 degrees to 89.7 degrees at the end of the recording. During the increase in right engine EPR, an increase to approximately +0.2 g's (positive values are defined as forward acceleration) of longitudinal acceleration occurred within the FDR sampling rate.

DC-9 Hydraulic System Testing

The hydraulic tube was loosened at the base of the alternate hydraulic motor/pump sump. Less then a cup of fluid drained. The reservoir when full contains approximately 2.5 quarts of hydraulic fluid.

The right side hydraulic reservoir was serviced to full and the right hydraulic system was pressurized utilizing the system hand pump. A leak emanated from a crack in the housing near

the input pressure port of the rudder shutoff valve, part number 3772374-5503 G, serial number RON 1185, which had a recorded total time in service of 62,436 hours. The rudder shutoff valve was removed and sent to the National Transportation Safety Board's Materials Laboratory for further examination.

The left system engine driven pump, Vickers, part number 314195, serial number MX192023P, was removed from the airplane for operational testing per the Vickers component maintenance manual 29-10-02.

The testing was performed under the supervision of the NTSB Systems Group Chairman at the NWA's Hydraulic Component Shop. The test results were documented in the System's Group Chairman's Factual Report, which is included in the docket.

DC-9 Metallurgical Examination of Rudder Hydraulic Shutoff Valve

Examinations of the assembled valve uncovered a longitudinal crack adjacent to

the upper side of the "B" port. With the valve assembled, about 0.4 inch of the crack was visible following the mold line on the exterior surface of the valve body. The mold line had been transversely ground around most of the periphery of the valve body including the location of the crack. With the valve disassembled, the exterior crack became clearly visible running across the threads in the "B" port. The crack intersected a cross drilled hole that connects the "B" port to the filter element area of the "E" port. A second crack was visible on the opposite side of the cross hole. The second crack was in the valve wall separating the "E" port from the "D" port that contains the valve sleeve. The second crack was completely internal to the valve body. The externally visible crack will be referenced as the thread wall crack and the internal crack will be the sleeve wall crack. The cracks were parallel to each other and in the same plane as the mold line of the valve body casting.

The sleeve wall crack measured approximately 0.5 inch. Magnified optical examinations of the crack faces uncovered shiny faceted regions consistent with fatigue propagation in aluminum alloys on both cracks. On the thread wall crack, fracture features indicated fatigue initiation near the crest of the partial thread adjacent to the cross drilled hole. Features on the sleeve wall crack faces indicated initiation in the middle of the bore surface between the .B. and .D. ports. Scanning electron microscope (SEM) viewing of the thread wall crack found fatigue features and striations emanating away from a region of indistinct fracture features at the crest of the partial thread. From the origin, the fatigue propagated forward as indicated by fatigue striation and arrest lines and terminated near the exterior valve surface. Dashed lines in the central view of figure 5 indicate the fatigue terminus. Between the terminus and the original visible end of the crack, the crack surface consisted of ductile dimples and fractured silicon second phase particles. Backscattered electron imaging showed a different surface composition in the indistinct origin region when compared to the rest of the fracture surface. Energy dispersive x-ray spectra (EDS) and maps found this area to be relatively higher in silicon and oxygen content than the bulk material elsewhere. The spectrum for the base metal was predominately aluminum with some silicon consistent with the specified material, 356 aluminum casting alloy. SEM examinations of the sleeve wall crack surfaces found fatigue striations emanating from an area of shrinkage porosity adjacent to the bore surface. The visible area of porosity was about 0.006 inch in diameter and located about 0.025 inch from the bore surface. From the porosity, the fatigue progressed generally upward for about 0.5 inch. The sleeve wall and thread wall cracks intersected many additional areas of shrinkage

porosity as shown in figure 9. In most instances the porosity areas were subsurface and less than about 0.025 inch in diameter. As few small surface connected pores were found at the thread wall crack.

Fatigue striations were visible throughout the fatigue region and the striation

spacing was measured at six locations generally along the center of progression in the sleeve wall crack. Using the measured striation spacing (da/dN) and the relative locations of the measurements to the origin, about 84,000 total striations were calculated to be present in the first 0.42 inches of progression as shown in the table below.

DC-9 Nose Wheel Steering Examination

Examination of the nose wheel steering system was performed by utilizing a ground hydraulic power cart to pressurize the left hydraulic system. The tiller was moved right and then left and the nose wheels moved at least 45 degrees in the corresponding direction. The FO's pedals were moved in both directions and the nose wheel moved approximately 10 degrees in the corresponding direction.

JT8D-17 Engine Residual Thrust Test Run

A JT8D-17 engine was test run in a NWA test cell in order to determine the minimum engine pressure ratio EPR at idle. The minimum observed EPR reading was 1.04. Test cell data for five recently removed JT8D-17 engines indicated that minimum ground idle level was 1.04 - 1.05.

Reliability Information

National Transportation Safety Board Recommendation A-93-61 through -64, relating to the FAA's Service Difficulty Reporting (SDR) program states, in part, that "The SDR system only contains a small percentage of the actual occurrences and the service and safety data maintained by the manufacturers are more useful, comprehensive, and timely than the FAA'SDR."

On September 15, 2000, the FAA published a final rule that addressed the SDR system. The final rule revised the reporting requirements for air carrier certificate holders and certificated domestic and foreign repair stations concerning failures, malfunctions, and defects of aircraft and associated systems and components. The final rule also clarified and standardized the type of information submitted, allowing the FAA to identify trends that affect aviation safety.

On September 14, 2005, the FAA published a notice of proposed rulemaking that withdrew the SDR rule issued on September 15, 2000. The FAA indicates that it will form a workgroup to study the SDR system, including the numerous comments it received that led it to postpone, and eventually withdraw, the rule. This workgroup will submit new suggestions on improving the SDR system, and at that time, the FAA will initiate new rulemaking. The Safety Board has noted with concern the continued delays to improvements needed for the SDR system, including the FAA's withdrawing the rule that would have made the needed changes. Consequently, the Safety Recommendations A-93-61 and A-97-125 were classified as "Closed-Unacceptable Action."

A Boeing Service Letter (SL), DC-9-SL-27-103, dated May 6, 2005, addressed Aileron/Rudder Shutoff Valve Reliability for DC-8, DC-9, MD-80, and MD-90 series airplanes. NWA reported that their SCEPTRE records show that this SL was received by NWA on May 19, 2005. This SL

states the following:

Based on the failure history of the aileron/rudder shutoff valve housing, P/N 5914351 (References a through d), operators may wish to implement a maintenance program to replace the existing rudder shutoff valve cast housing with a machined rudder shutoff valve housing to minimize flight disruptions.

The SL Background states that since 1985, three cracked housings were analyzed by Boeing. The common cause of failure was fatigue, which nucleated at shrinkage cavities and site of porosity located at the intersection of the threaded end of the 0.435 inch diameter pressure port "B" and the tapered base of the 0.563 inch diameter hole. The casting quality in the area inspected was considered suspect. It was determined that the castings were of a grade "D", while blueprint requirements are a grade "C" minimum. The specific source of the castings could not be determined. Therefore, it was not possible to identify a suspect batch of parts. Boeing issued a supplies alert to all of the current suppliers, notifying them of the discrepancies, and requesting all in-process and completed valves be inspected for proper casting quality.

The SL Discussion states, "To date, approximately 77% of the 29 total reported failures occurred in the 30,000 to 65,000 flight-hour range. Approximately 15% of the total reported failures occurred in the 20,000 to 30,000 flight-hour range and 8% of the total reported failures occurred in the 14,000 to 17,000 flight-hour range.

Boeing purchasing records indicate that the cast housing tooling was scrapped in 1999. After the cast housing inventory was depleted, new spare housings were authorized to be made from 6061-T6511 plate aluminum. All spare housings, manufactured after 1999, are machined from plate aluminum; therefore, porosity is no longer an issue. All machined housings have a green color exterior surface. In addition, machined parts do not have the raised (cast) part number identification. Neither the machined or cast housings were serialized nor was there a part number change when the machined housing was introduced. To date, Boeing has not received any failure reports of the machined housings.

The SL was amended and dated September 7, 2006, to reflect a change in P/N to Background narrative and removal of the Discussion narrative. The P/N was changed to 5614351 and the Background narrative stated that there were three cracked housings prior to 1990 with the removal of casting quality background.

A query of the FAA's SDR system for DC-8, DC-9, MD-80 aileron/rudder control system valve yielded 71 records using the search string "aileron/rudder control system - valves" for DC-8, DC-9, and MD-80 airplanes.

The SDR query for DC-8 airplanes indicates that prior to 1995 there were a total of 3 records of "cracked" rudder shutoff valves. During the time period from 1995 to December 1, 2006, there were no records of "cracked" rudder shutoff valves.

The SDR query for DC-9 airplanes indicates that prior to 1995 there was a total of 11 records involving "cracked," "leaking," failed," "malfunction," or "defective" rudder shutoff valves. Of this total, 2 were "cracked," 3 were "leaking" from an unspecified location of the rudder shutoff valve with an associated loss of hydraulic system pressure, 3 were "leaking" from an unspecified location without a record of hydraulic system pressure, and 1 "failed," 1 "defective," and 1 "malfunction" with a hydraulic pressure loss.

During the time period from 1995 to December 1, 2006, there were 9 records of "cracked" or "leaking" rudder shutoff valves.

The SDR query for MD-80 airplanes indicates 1 record of a "cracked" rudder shutoff valve.

There were no SDR records for the MD-90.

The Northwest Airlines Continuing Analysis and Surveillance System recorded 38 instances of DC-9 rudder shutoff valve housing failures over a time period of May 2000 to April 2005.

NWA reported that they were aware of the cracked valve housings of the rudder shut-off valve prior to the accident as a result of ODI events and other failures caused by cracks in the valve housings. NWA considered the cracked housing to be an age-related failure mode and a reliability issue and as such the issue was evaluated, analyzed, and responded to using reliability oriented decision-making methods and practices.

In July 2003, NWA Component Engineering requested a Weibull analysis of this component to evaluate whether a maintenance program change would be indicated by the analysis. The Weibull analysis results showed a random failure distribution with a Beta of 1.05, the failure of the valve by itself was not determined to be a safety of flight issue, and a maintenance program change was not merited. Failures of the housings continued to be experienced with subsequent reviews conducted but as this was a reliability item and not a safety of flight concern, the benefit for enhancing the reliability of the valve did not exceed the cost to do so. The manufacturing process for the valve housings was changed from casting to machining in 1999 (to eliminate the porosity issue at the heart of the cracking issue) and since that time all failed housings have been replaced on attrition with machined housings. Component Engineering at NWA's Minneapolis maintenance facility has not reported any failed valves to Boeing since 2003. Maintenance of the DC-9 rudder shut-off valve was previously contracted to Fortner Engineering from 1997 to July 2005 and Fortner advises that a review of their communications did not find any formal correspondence to Boeing regarding NWA's failed housings. NWA submitted 2 housings to Boeing for analysis in October 1996. Radiographic inspection of the valve housings resulted in a grade "D" rating for elongated gas porosity. The engineering drawing specifies grade "C" castings. No other housings have been supplied to Boeing by NWA for analysis.

The failure of the valve by itself was not determined to be a safety of flight issue and was therefore deemed solely a reliability issue. The benefit for enhancing the reliability of the valve did not exceed the financial consequences of the continued failures. Had the valve failures been determined to be an actual safety of flight issue, financial justification would not have been a factor in NWA's response.

ADDITIONAL INFORMATION

Parties to the investigation are the Air Line Pilot Association, Aircraft Mechanics Fraternal Association, Federal Aviation Administration, Northwest Airlines Inc., and the Professional Flight Attendants Association.

Both airplanes and respective component parts, if any, were released to NWA on May 15, 2005.

Pilot Information

Certificate:	Airline Transport; Commercial	**Age:**	48, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):		**Toxicology Performed:**	Yes
Medical Certification:	Class 1	**Last Medical Exam:**	11/01/2004
Occupational Pilot:		**Last Flight Review or Equivalent:**	07/01/2003
Flight Time:	10811 hours (Total, all aircraft), 6709 hours (Total, this make and model), 6709 hours (Pilot In Command, all aircraft)		

Co-Pilot Information

Certificate:	Airline Transport; Commercial	**Age:**	44, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):		**Toxicology Performed:**	Yes
Medical Certification:	Class 1	**Last Medical Exam:**	10/01/2004
Occupational Pilot:		**Last Flight Review or Equivalent:**	07/01/2004
Flight Time:	3985 hours (Total, all aircraft), 3985 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	McDonnell Douglas	**Registration:**	N763NC
Model/Series:	DC-9-51	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Transport	**Serial Number:**	47716
Landing Gear Type:	Tricycle	**Seats:**	131
Date/Type of Last Inspection:	08/01/2004, Continuous Airworthiness	**Certified Max Gross Wt.:**	123200 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo Fan
Airframe Total Time:	67268 Hours	**Engine Manufacturer:**	Pratt & Whitney
ELT:	Not installed	**Engine Model/Series:**	JT8D-17
Registered Owner:	Northwest Airlines Inc.	**Rated Power:**	15200 lbs
Operator:	Northwest Airlines Inc.	**Air Carrier Operating Certificate:**	Flag carrier (121)
Operator Does Business As:		**Operator Designator Code:**	NWAA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	MSP, 841 ft msl	**Observation Time:**	1853 CDT
Distance from Accident Site:		**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Temperature/Dew Point:**	16°C / 13°C
Lowest Ceiling:	Broken / 3900 ft agl	**Visibility**	10 Miles
Wind Speed/Gusts, Direction:	10 knots, 230°	**Visibility (RVR):**	
Altimeter Setting:	29.91 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Columbus, OH (CMH)	**Type of Flight Plan Filed:**	IFR
Destination:	Minneapolis, MN (MSP)	**Type of Clearance:**	IFR
Departure Time:	1826 EDT	**Type of Airspace:**	

Airport Information

Airport:	MINNEAPOLIS-ST PAUL INTL/WOLD-(MSP)	**Runway Surface Type:**	Concrete
Airport Elevation:	841 ft	**Runway Surface Condition:**	Dry
Runway Used:	22	**IFR Approach:**	
Runway Length/Width:	10006 ft / 150 ft	**VFR Approach/Landing:**	Full Stop

Wreckage and Impact Information

Crew Injuries:	1 Serious, 3 Minor, 1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	94 None	**Aircraft Fire:**	None
Ground Injuries:	3 Minor	**Aircraft Explosion:**	None
Total Injuries:	1 Serious, 6 Minor, 95 None	**Latitude, Longitude:**	44.880556, -93.216944

Administrative Information

Investigator In Charge (IIC):	Mitchell F Gallo	**Adopted Date:**	04/25/2007
Additional Participating Persons:	Christine K Soucy; Federal Aviation Administration; Washington, DC Patrick Schmitz; Northwest Airlines; Eagan, MN Gordon Burgess; Airline Pilots Association; Eads, TN Gary Helton; Professional Flight Attendants Association; Bloomington, MN Rick Arenas; Aircraft Mechanics Fraternal Association; Laconia, NH		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		

The National Transportation Safety Board (NTSB), established in 1967, is an independent federal agency mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report.